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Copiapoa

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The Cactus File Handbook 4

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Series Editor: David Neville

Maps: Joanne King

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First published in 1998 by Cirio Publishing Services Ltd

5 Chevron Business Park, Lime Kiln Lane, Holbury, Southampton SO45 2QL, UK

Printed by: Drogher Press, Christchurch, Dorset

Origination by: Pace Colour, Southampton

ISBN: 0 9528302 6 4 (softbound)

ISSN: 1363-5727

Front cover picture: *Copiapoa cinerea* var. *longistaminea* in habitat at Esmeralda, Chile
(Photograph by Graham Charles)

Back cover picture: The author with a large, old specimen of *Copiapoa cinerea* var. *dealbata*
17km north of Carrizal Bajo, Chile
(Photograph by Chris Pugh)

THE CACTUS FILE HANDBOOK

4

Copiapoa

by Graham Charles

PREFACE

In writing this, my first book, I have aimed to provide the cactus enthusiast with a convenient guide to *Copiapoa*, one of the most interesting of South American genera. I believe that this is the first guide written in English to cover all the species in the genus. Much of the information in this book can be found by looking through the literature written by various scholars and adventurers over the years, and published in many different languages. I have tried to present this history in a readable format and, from my years as a grower and from my visit to the habitat of these plants in 1994, to add some personal touches which I hope will inspire the reader.

Copiapoas have been particularly popular in recent years, due in part to their listing in Appendix 1 of CITES — a sure way to make endangered species more desirable to some collectors. The genus has since been removed from Appendix 1, so allowing seeds to be legally imported and grown commercially to satisfy demand without the need for illegal collection of wild plants which does so much damage to habitats.

As with many cactus genera, far too many names were erected in the past by various authors. I have followed the work in previous reviews of the genus by Nigel Taylor and Adriana Hoffmann in accepting a reduced number of species and varieties. Many of the familiar names for individual populations still have a place on plant labels, but perhaps they should be considered as forms. Although the primary aim of this book is not taxonomy, I found I could not follow the uncritical approach taken by other recently published books on *Copiapoa* which perpetuated a plethora of names which was the norm a few years ago. I found myself in the classic dilemma which has stopped so many knowledgeable growers in the past from recording their thoughts: there is always so much more to know. If I went back to look at them in the habitat one more time....but then you never publish anything. This is my best attempt based on my current understanding of the plants.

I hope readers will be able to use this book to review the names on their plant labels and using the illustrations, decide on a rational nomenclature. It is regrettable that so many copiapogas have been distributed with hopelessly wrong names. I have tried to use only illustrations of plants from known, reliable sources, but one has to bear in mind that every plant is an individual: each species will show a degree of variation between specimens, and the effects of cultivation upon the appearance of the plants can be misleading.

Graham Charles
Stamford, June 1998

ACKNOWLEDGEMENTS

The cactus growing hobby has enriched my life with many friends. Without them, I would not have attempted this book. My interest in South American cacti was particularly stimulated by 'The Chileans', a small society for enthusiasts of these plants, led by the tireless Harry Middleditch. Its specialist members taught me so much, and prompted my first visit to South America in 1992. I owe my initiation to habitat adventures to Ken Preston-Mafham, Roger Ferryman and to my friend for 35 years, Chris Pugh. We have all spent many happy hours together, usually in a bar, discussing what we have seen, and what to look for next. I am grateful for the practical help given to me by Roger Ferryman and Alan Craig in the preparation of the text of this book, and to Roger Ferryman, Alan Craig, John Ede and Tom Jenkins for allowing me to use so many of their pictures. Roger has made more than a dozen trips to Chile over many years and has accumulated a vast knowledge about the plants of that country.

I must also thank my work colleagues, Ally Flynn and James Fordham, for some of the translations from Spanish and German. The encouragement and support of David Neville and the team at Cirio Publishing is gratefully acknowledged. But most of all I must thank my wife Elisabeth for her love and understanding, and for proof reading the text. Even though I am fortunate that she shares an interest in cacti, I think it was the copiapoas which she saw in my collection when we first met which made her want to persuade me to the attractions of mammillarias and haworthias. This book proves that she was only partly successful!

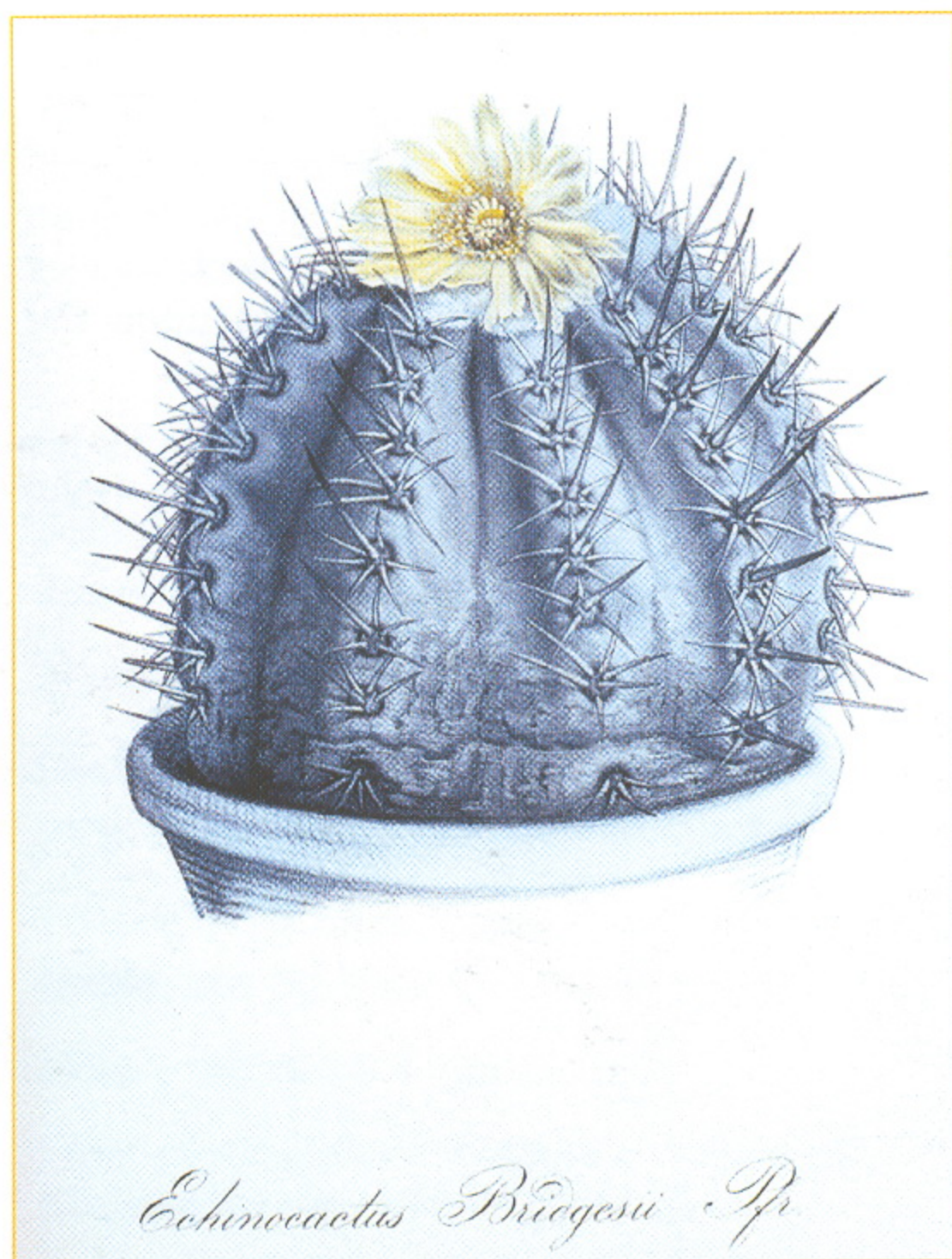


Fig.1 *Echinocactus bridgesii* from
Pfeiffer, Abbildung und Beschreibung Blühende
Cacteen 2 (1846–1850) Plate 14

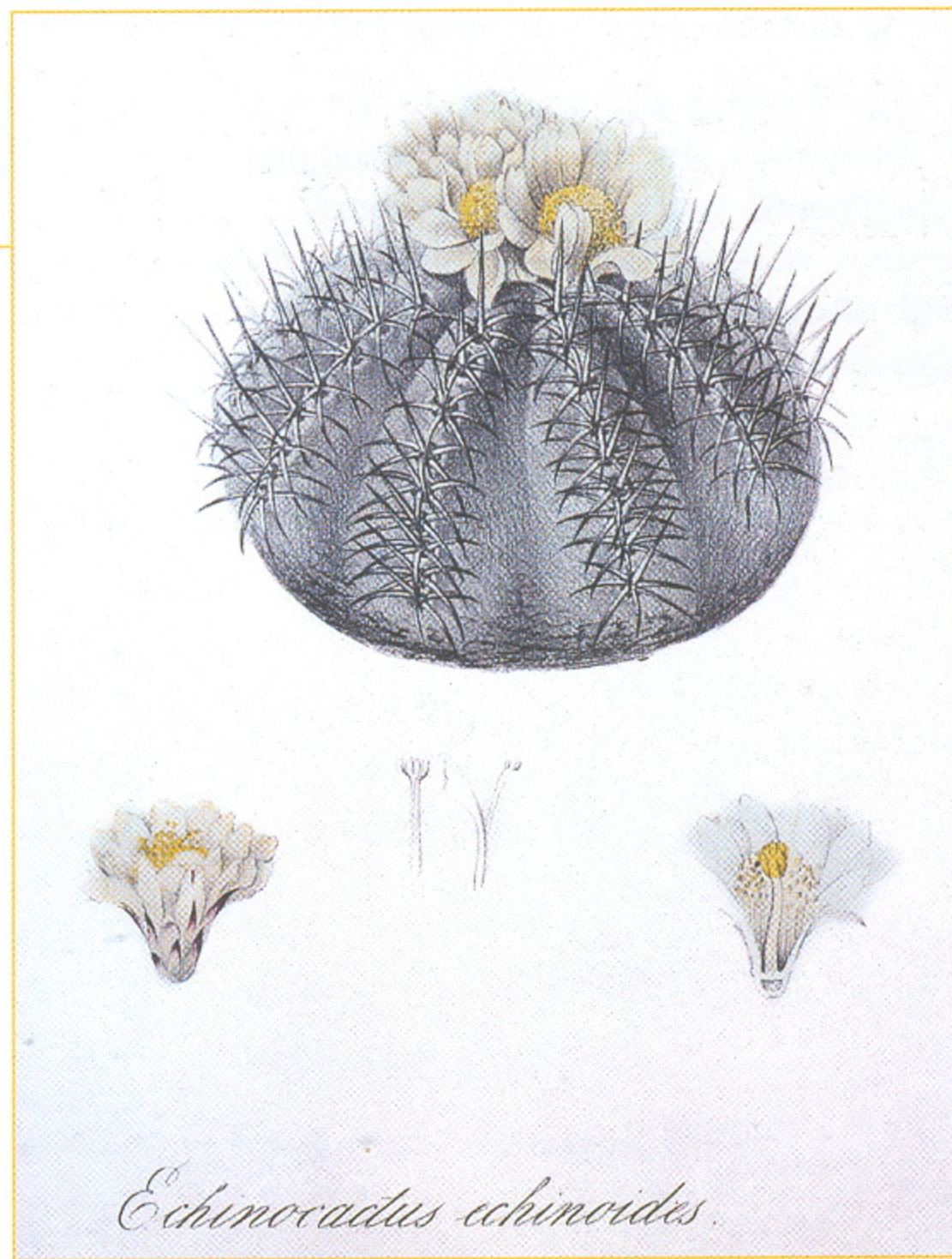


Fig.2 *Echinocactus echinoides* from
Pfeiffer, Abbildung und Beschreibung Blühende
Cacteen 2 (1846–1850) Plate 29

INTRODUCTION TO COPIAPOA

Copiapoa is a most individual genus, with characteristics that are so clearly defined that there is no argument about which plants are contained within it — more than can be said for many other genera. It has no obvious close relatives in the Family Cactaceae, suggesting a long evolution away from the mainstream of development, brought about by the isolation of its habitat niche. Perhaps climatic change has caused the extinction of the plants which formed links to the other genera we know today. Whatever their origins, these remarkable plants fascinate us today as much as they must have done when they were first recorded to science in the middle of the 19th century.

A dozen or so names for plants which were eventually to be known as copiapoas were published prior to 1890, most of which were the result of plants collected by the English explorer Thomas Bridges, who visited the area between Coquimbo and Copiapo in the latter half of 1841. The plants he sent back to Europe were later described by Salm-Dyck, Pfeiffer and W.J. Hooker as species of *Echinocactus* (Figs. 1, 2 & 3); much later, in the next century, they were transferred to the newly erected genus *Copiapoa*.

R.A. Philippi, a German botanist, emigrated to Chile in 1851 and having made an extensive trip to the Atacama during 1853 and 1854, described three new plants which have since been recognized as copiapoas.

The next significant development was the recognition by Britton and Rose of a group of plants from northern Chile exhibiting a number of common characteristics which they felt warranted the erection of a new genus. In Volume III of *The Cactaceae*, published in 1922, they erected the genus *Copiapoa*, citing the type species as *Copiapoa marginata* (Salm-Dyck). They used the following description to define the genus:

Simple, globular to elongate-cylindric, or in one species forming large clumps or mounds containing hundreds of simple globular stems; areoles borne on definite ribs; top of plant covered with dense soft wool; flowers from the top of the plant, nearly hidden in the wool, campanulate to funnelform, yellow or sometimes tinged with red, with very short but broad tube; ovary short, turbinate, naked; fruit small, smooth, crowned with green, persistent, sepal-like scales; seed large, glossy, black, with large depressed hilum.

The name of the genus *Copiapoa* was derived from the Chilean province of Copiapo, and initially included six species recognized by Britton and Rose, some of which had been collected or re-collected by Dr. Rose during his visit to Chile in 1914. They derived these six species from fourteen original descriptions — an early example of lumping! The recognized species were *C. cinerea*, *C. marginata*, *C. coquimbana*, *C. cinerascens*, *C. echinoides*, and *C. megarhiza*. They thought that *Echinocactus humilis* Philippi probably belonged to this genus, but it had to wait until 1953 before it was finally transferred to *Copiapoa* by Paul Hutchison. Hutchison also wrote an excellent article in the subsequent issue of the US Journal about *C. cinerea*, adding much to our understanding of this plant and particularly its diversity.

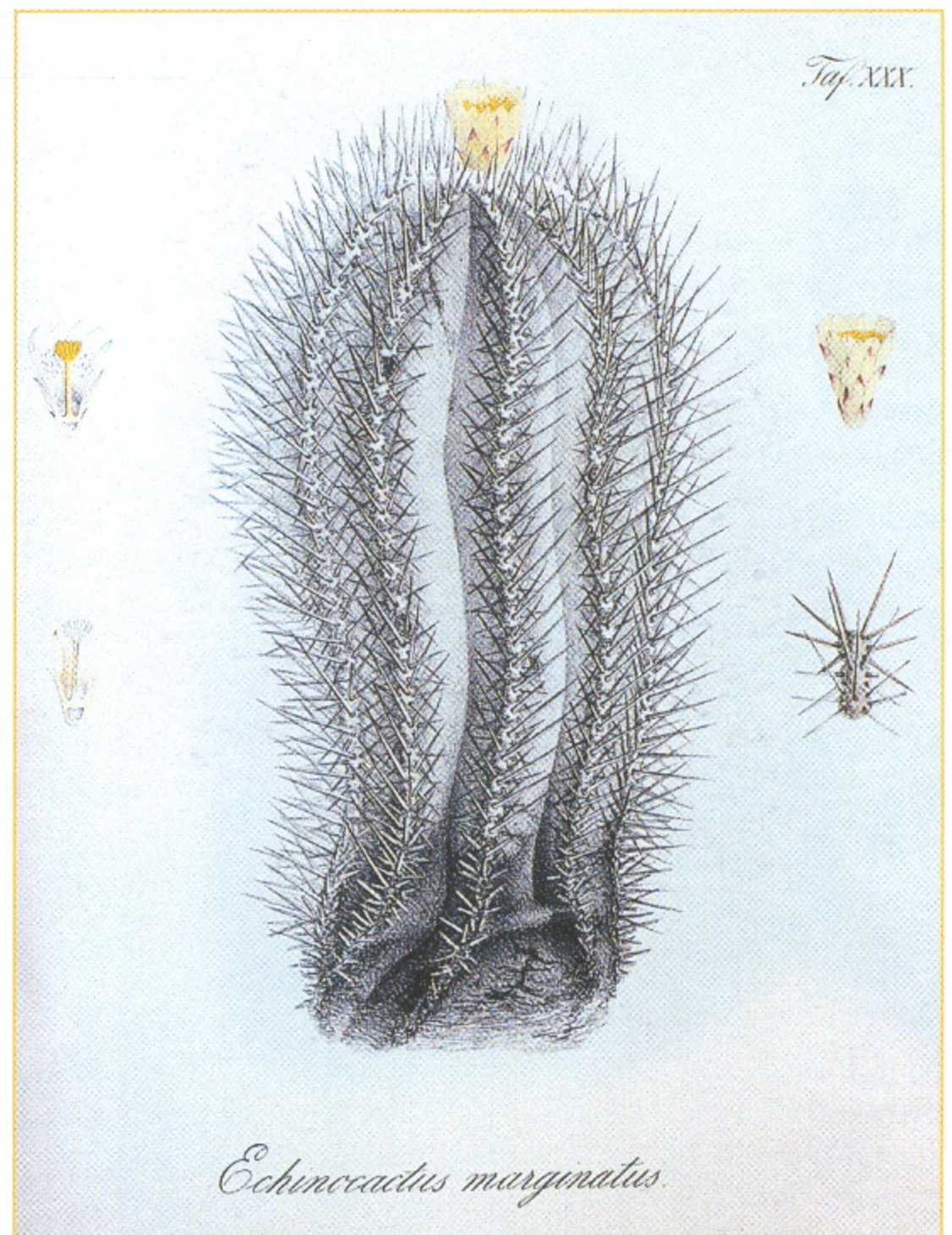


Fig.3 *Echinocactus marginatus* from Pfeiffer, Abbildung und Beschreibung Blühende Cacteen 2 (1846–1850) Plate 30

The writings of Backeberg were extensive, but far from thorough. Unfortunately, in volumes II and VI of *Die Cactaceae*, he made various errors which mislead the reader.

One of Backeberg's greatest critics, Friedrich Ritter, probably did more for *Copiapoa* than any other person. His extensive explorations of Chile, where he lived for some time, revealed many new plants and resulted in him publishing 36 new species in this genus alone. His desire to publish each slightly different form as a new species is not fashionable today, but this should not detract from the wealth of information in his writings, particularly those about Chile. It was not until he was in his eighties that he published his four-part work *Kakteen in Südamerika* (1979-81), and this is still one of the primary sources of information about this genus.

In 1991 in the journal of the Cactus and Succulent Society of Great Britain (Vol. 43, Nos. 2-3), Nigel Taylor published a useful commentary on *Copiapoa*. This was the first published attempt to rationalize the species. He accepted 17 species and a number of varieties, although some combinations were only suggested.

Since then, the useful book *Cactáceas – en la flora silvestre de Chile* by the Chilean botanist Adriana Hoffmann includes many fine paintings of copiapoas which illustrate their characteristics remarkably well. Hoffmann accepted 18 species of *Copiapoa*, and a further 27 varieties. It is from this book that you can obtain an up-to-date description of the genus, which appears to be based on that of Ritter (1980). A translation of this follows:

"The copiapoas are generally succulent, bushy plants, of a simple or multi-headed cushion structure. Some species have a geophytic life, with the stem growing along or below the surface (e.g. *Copiapoa hypogaea*, *C. tenuissima*, etc.). The plants can be between 2cm and 2m diameter and the colour varies from whitish to a blackish-green, passing through grey, brown, green, red-brown etc. The roots are bunched together, fibrous or swollen and pivotant (i.e. they enter the earth

perpendicularly) — there may be a thin stem, or none at all. At maturity the crown develops a woolly layer which is prevalent in more or less all species once they flower. The young specimens, and even some adult varieties do not have well defined ribs. Some are divided into tubercles. The areoles are found on the tubercles and also by their side. Equally, the number of spines can vary greatly, from none to many. They are needle-like or awl-shaped, straight or slightly bent, but never hooked. Their colour also varies greatly, from white to black, passing through yellow, chestnut, brown, red-brown, etc. Some or many of the central spines are usually more developed than the radial spines, but they are never more in number.

"The flowers are usually yellow with the outer petals sometimes marked with a reddish purple colour. In a few varieties the entire flower is red (e.g. *Copiapoa desertorum*). The pericarp (seed pod) is of an angled round shape and nearly always hairless, with the exception of *Copiapoa solaris*, *C. tocopillana* and *C. tenuissima* (the more northern species for the genus) which have a woolly covering. In all varieties, bristles are missing completely; scales can appear or not on the top side of the pericarp (seed pod). Only on *C. solaris* do small scales appear all over its surface. The floral tube is short and in the form of a very open funnel. In the interior of the flower the nectar chamber is very developed; short and tubular, generally covered by deeply inserted

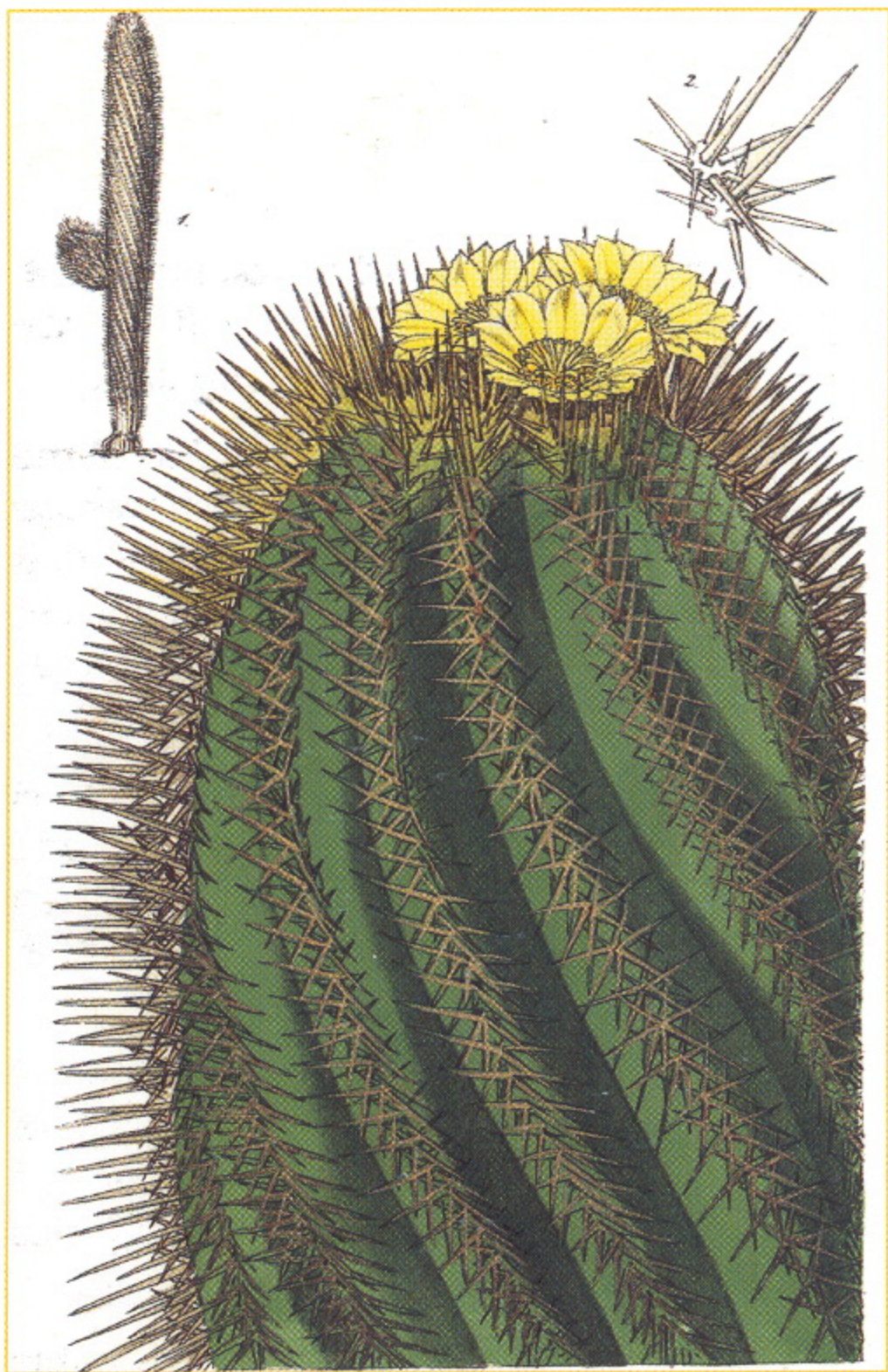


Fig.4 *Echinocactus streptocaulon* from Curtis's Botanical Magazine: 77: (1851) Plate 4562

stamens. The stamens and pistil are always pale yellow; the anthers are usually found below the stigma lobes. Perianth segments, or petals, are usually spatulate. Pollination is carried out by insects, normally different species of flies and bees.

“The fruits are specially structured so that the seeds are dispersed by ants. The walls are relatively thick and are not hyaline, unlike other cacti. At maturity, the funicles, where they are attached to the seeds, become softer and sweeter thus attracting insects. The dehiscence takes place through a small round cover that opens in the upper part of the fruit. This fruit is not clearly related to any other in the family. That is due, surely, to its completely isolated evolution restricted to the coastal area of northern Chile. The seeds are black, matt or shiny, smooth or covered in a fine, smooth excrescence. The hilum is oval-shaped enclosing a small micropyle. The germination of the seeds in culture is therefore generally easy. In the wild, however, germination conditions are usually very difficult, and it is very rare to see plants in their embryonic state amongst a cactus population.”

It can be seen from this description that *Copiapoa* have a number of characteristic features, most notable I think being the seed pods which open in a unique way, with a lid on the top which is forced open as the seeds ripen. When looking for seeds in the wild, you must look for flower remains of a specific age, and then you can dig the seed pod out of the wool. If you are too early then the seeds will not be ripe, too late and the ants will usually have got there first.

The way copiapoa offset is also interesting, in that the offsets burst out through the skin of the main body in a similar way to *Echinocereus* — this can also be seen in some species of *Trichocereus*, but is not common generally in the Family Cactaceae. A consequence of this behaviour is that offsets removed as cuttings tend to have large cut surfaces, which can result in significant dehydration before rooting starts. And, of course, the parent plant is badly scarred in the process of taking a cutting.

In 1957 Ritter erected a separate genus, *Pilocopiapoa*, for the single species *P. solaris*; the genus was based on various minor differences to *Copiapoa*, notably the woolly covering of the pericarpel and floral tube. Although this is a particularly individual species, the differences have not been considered significant enough to warrant a separate genus, particularly bearing in mind that *C. humilis* var. *tenuissima* and *C. humilis* var. *tocopillana* also have this wool.

The latest published work concerning *Copiapoa* is a review of *C. cinerea*, and its varieties and forms, by Rudolf Slaba in *Kaktusy* XXXIII Special (1997). This introduced the fashionable rank of subspecies and perpetuates all the Ritter names, many of which I believe are unnecessary for this variable species. I have followed his combination of *C. krainziana* and *C. longistaminea* as varieties of *C. cinerea*.

The plants have a long flowering season in habitat, covering many months, and probably stimulated by the availability of water. This is also true in cultivation where flowers can be expected all through the growing season. I have found some species to be self-fertile, although fruits produced by cross pollination between two clones have a higher proportion of viable seed.

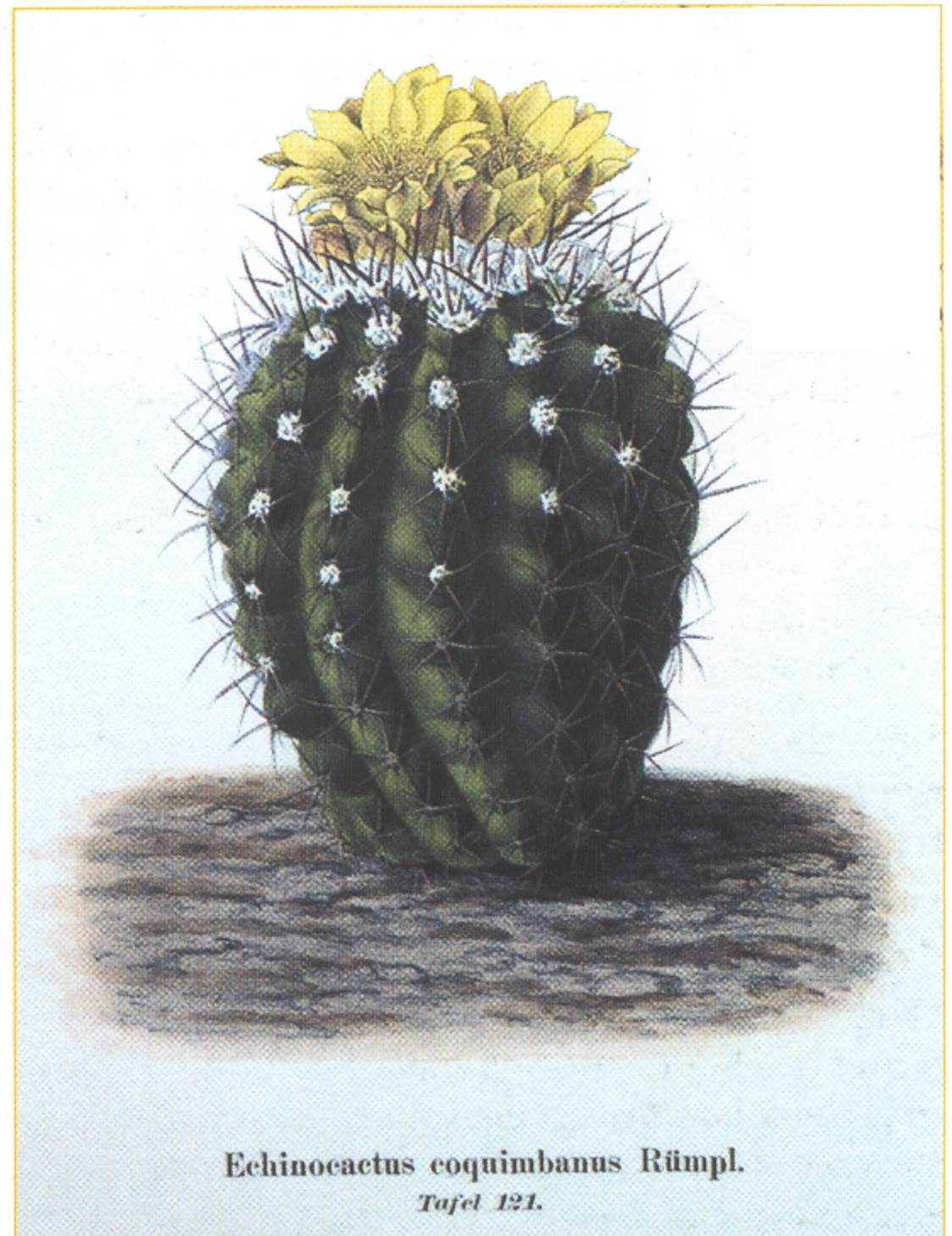


Fig.5 *Echinocactus coquimbanus* from
Blühende Kakteen, Gürke (Schumann)
(1909-1910) Plate 121



Fig.6

Copiapoa sp. RMF 53 in habitat at Caleta Botija

Fig.7

Copiapoa sp. RMF 53 in cultivation

It is clear that individuals can live to great age in habitat — probably hundreds of years in the case of the larger growing species. This is in keeping with the small number of seeds which are able to successfully germinate and grow to reach maturity in such a harsh environment; the longevity of the plants helps to maintain a stable population. I wonder how often a season is wet enough to enable seedlings to become established, or if a number of suitable consecutive seasons are required to ensure the plants' survival? The absence of young plants was obvious in many places during my visit to the habitats of several of the species, but encouragingly, reports from the field during the Chilean summer of 1997/8 speak of many seedlings in evidence.



Even though the habitat range of *Copiapoa* has been extensively explored, there are probably more distinct species and varieties to be discovered and described. It is clear that the plant assigned the Roger Ferryman field collection number RMF 53 (Figs. 6 & 7), a small-headed, clumping plant which many travellers have seen growing near the road at Caleta Botija, near Miguel Diaz, does not have a name and is likely to be described in the future as a new species. Further up the same valley, the plant known as 'species Botija' (Fig. 8) needs to be described, perhaps as a variety of *C. cinerea*. There are likely to be others, perhaps inconspicuous plants with a limited distribution, and so the story of the genus continues.

Fig. 8 *Copiapoa* 'sp. Botija' in habitat in the Botija Valley

ENVIRONMENTAL CONDITIONS OF COPIAPOA HABITATS

Copiapoa occupy a specific ecological niche found in a defined area of northern Chile. They have adapted to exist in these particular conditions and occur nowhere else. To understand this, we need to look at what characterizes their distribution range.

Chile is a long, thin country: 2,600 miles long, but only 100 miles across at its widest point. The eastern border with Argentina and Bolivia roughly follows the line of the high Andean peaks, while the western border is the sea coast. The two principal mountain chains are the Andes and the older, coastal chain, with the central valley between them. In the regions which interest us in relation to *Copiapoa*, the coastal mountains and the central valley are crossed by a series of river valleys formed long ago when the climate was less arid. Today, the main source of water is from melting snow, although some storms do manage to edge over the high Andes from the east. Even so, many rivers in the north never reach the sea, while those further south are used for irrigation of the otherwise dry valley floors.

Chile has a remarkable diversity of climatic zones, both from north to south and from sea level in the west to the high Andes in the east. The central part of Chile has a Mediterranean-type climate, with reliable winter rainfall reaching approximately as far north as La Serena in the Elqui Valley. It is at this latitude that the most southerly *Copiapoa* occurs. The distribution of *Neoporteria*, *Opuntia*, *Trichocereus* and *Eulychnia* continues further south, and the plants are dependant on this winter rainfall for survival.

In the far north of Chile, within the tropics, there is a region of summer rainfall, originating from the South American basins in the east, but the precipitation becomes less reliable further west or south. Part of this region is an extension of the altiplano from Bolivia and Peru, but it also includes some west-facing slopes of the Andes. Cacti are plentiful in this area, but not *Copiapoa*, the distribution of which is further to the south and west, separated from the summer rainfall area by a barrier of total aridity where rain has never been recorded.

The *Copiapoa* distribution region is characterized by little actual rainfall, but frequent fogs or mists move inland off the sea on to the coastal hills, and to some extent up the valleys. Rainfall is irregular, with perhaps years between the occasional downpours. Even when it does rain the moisture can be of limited use to the plants,



Fig.9 View of Paposo, showing flowering annuals in a wet year



Fig.10 Bahia Inglesa from Morro Copiapo



Fig.11 View near Esmeralda, showing fog on the hills

for it runs rapidly off the dry slopes and does not penetrate the ground.

The whole area is becoming more arid. There is evidence that the increasing aridity has affected plant populations since Ritter travelled there in the 1950s; many large, dead and dying cacti can be seen throughout the area, where it was first too dry for seedlings to establish and now is too dry for mature plants to survive. It may be due to the impact of recent human activity, or perhaps is part of a very long term trend caused by the continued rise of the Andes.

The Humboldt Current carries cold water up the Chilean coast from the Antarctic. The cold, humid air from the sea moves inland over the hot dry land producing fog, a phenomenon which varies along the coast, and by altitude, depending on local topography (Figs. 11 & 12). It is this fog which provides *Copiapoas* with moisture and, where it is most intense, it can even support forests of non-xerophytic trees.

An infrequent and unpredictable event which has a dramatic effect on precipitation is the so-called El Niño effect, caused when cold water currents off the coast are disrupted and the surface temperature of the sea rises. This increases the amount of evaporation, so that fog and rainfall are more prevalent, and can result in the rare sight of desert annuals flourishing and erupting into flower (Fig. 9). During the many years in between these events the desert often receives no rainfall at all.

Taltal, a town famous in the cactus world as the location of *Copiapoa cinerea*, regularly has no recordable annual precipitation, but in an El Niño year the rainfall can be more than 60mm, although it may fall on only one or two days!

The distribution area for *Copiapoa* also supports other cacti such as species of *Neoporteria*, *Opuntia*, *Trichocereus* and *Eulychnia*. Also common are *Euphorbia lactiflua*, *Oxalis gigantea* and a number of bromeliads.

The amount of fog generally increases from north to south — the lack of it being the determining factor in the distribution of *Copiapoa*, which spreads no further north than Tocopilla. One could speculate that when the region was less arid the distribution went further north; perhaps the original evolution of this genus was from the north, but this is difficult to determine since *Copiapoa* has no obvious close relatives. The intensity of fog generally reduces as you go further north, but there is also considerable local variation in



Fig.12 Paposo, with fog forming on the hills behind the town

fog occurrence and density throughout the region, probably caused by topography, with damper areas occurring at certain altitudes or aspects where the fog drifts inland and makes contact with the soil and rocks. The effect of this variation is that some valleys can support copiapoa well inland, whereas others are too dry for the plants to grow there.

Copiapoa probably obtain their moisture from the fog, which dampens the soil surface and enables the roots to benefit from it, rather than any absorption through the skin or spines of the plant. The plants have a wide, spreading network of roots near

to the surface, and in some of the smaller species a tuberous root to increase storage capacity. I am uncertain if tuberous roots are a consistent characteristic which can be used in classification. It has been reported that tuberous roots in *Neoporteria* are not necessarily found in all plants of a population and the inconsistent documentation of this characteristic for some species of *Copiapoa* makes me wonder if the reality is that some individuals have it and others do not.

Even though *Copiapoa* habitats are near the tropics and at a low altitude, the air temperature is never very high due to the proximity of the cold sea. The highest monthly mean in summer is less than 25°C, with night time air temperatures in winter rarely falling below 5°C. The soil surface temperature exhibits a much more extreme range, from 50°C on a clear day in summer to below freezing some nights. The fog rolls in off the sea at night and usually clears in the late morning of the following day at about the same time as the on-shore breeze picks up. This breeze is always present in the afternoons, moderating the air temperature when the sun is at its strongest.



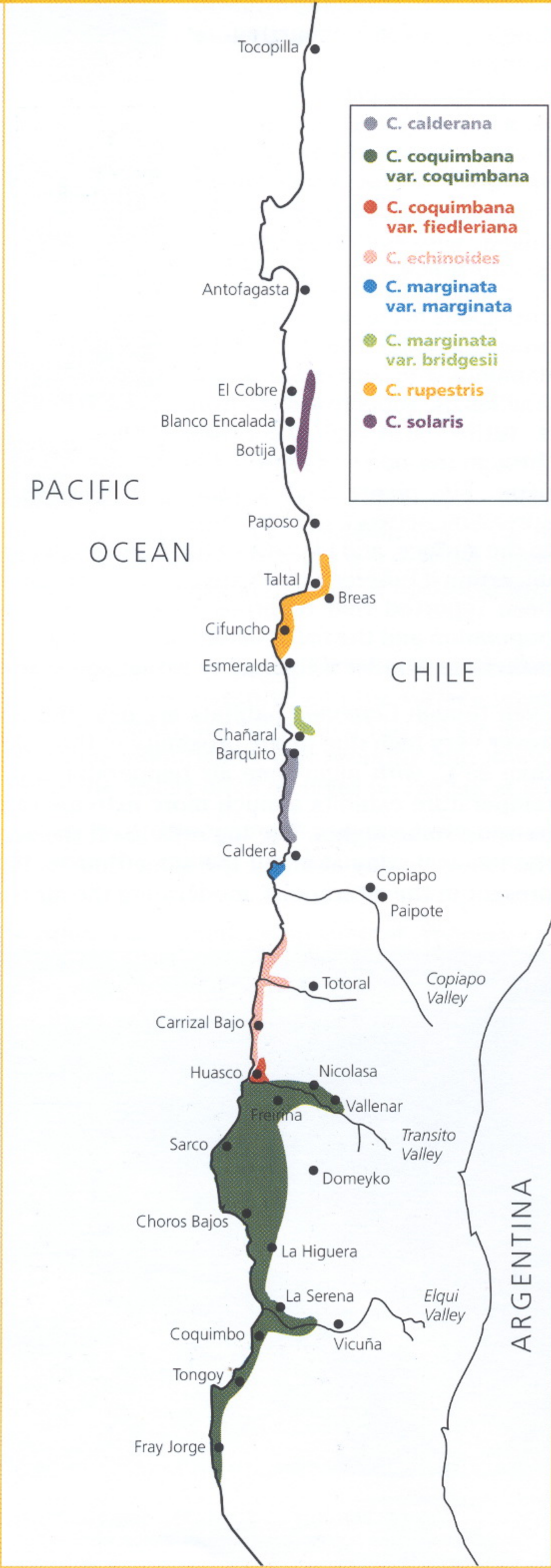
Fig.13 Habitat of *Copiapoa cinerea* var. *columna-alba* (*melanohystrix*) near Esmeralda

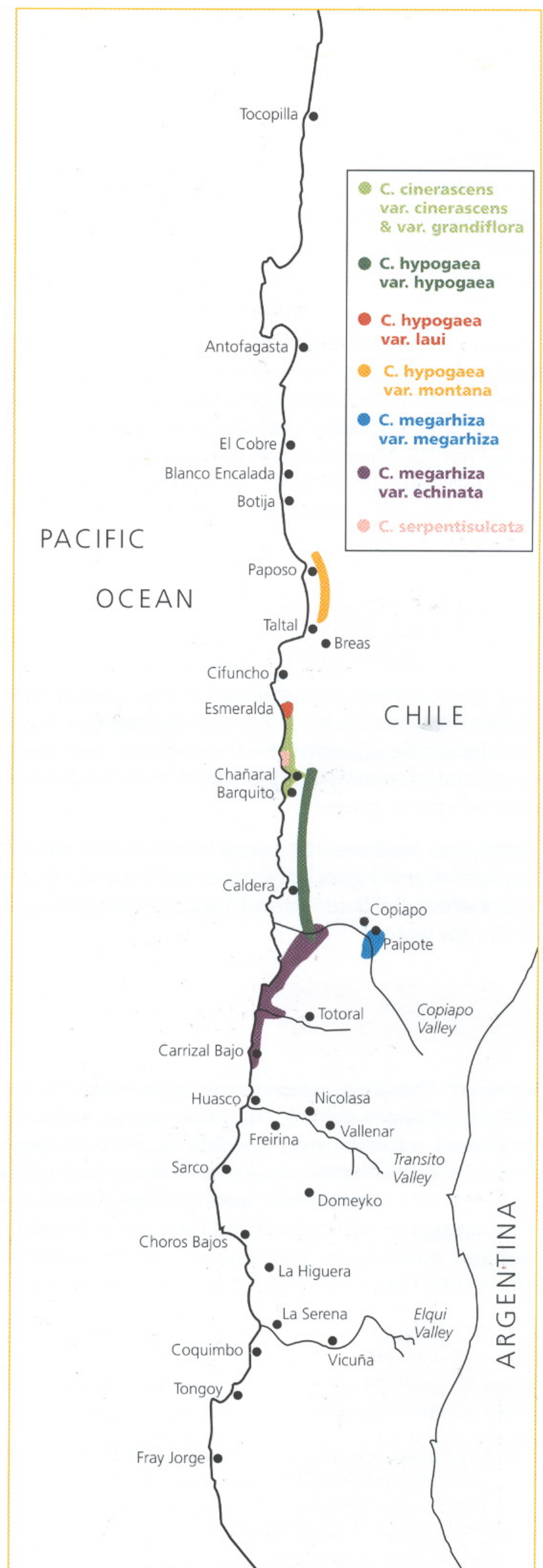


Fig.14 Habitat of *Copiapoa cinerea* var. *dealbata*, 27km north of Carrizal Bajo

The nature of the substrate in which *Copiapoa* grow in habitat appears to be largely mineral. Kraus (1995) reports that his tests on the soil showed nitrogen and carbon to be low and the pH was near to neutral, except for tests done at locations of *Copiapoa cinerea* var. *columna-alba* in Pan de Azúcar National Park which gave readings of pH 8.3 to 8.9 with high amounts of calcium. My own observations are that *Copiapoa* grow in gently sloping sand or gravel and sometimes in rock cracks. All the species I saw growing in rock cracks could also be found in the sandy localities, so I do not believe that any species has a particular preference.

HABITAT DISTRIBUTION MAPS





CULTIVATION

Copiapoas are generally not difficult to grow in greenhouse conditions in northern Europe. In cultivation it is quite easy to grow the 'soft-bodied species', such as *C. humilis* and *C. hypogaea*, so that they resemble plants growing in the wild, although this is much more difficult with the 'hard-bodied' species such as the *C. cinerea* forms. All copiapoas are all naturally slow growing, so patience is necessary. Attempts to speed growth will result either in atypical appearance or an early demise!

In cultivation, the soft-bodied species grow much larger than they do in habitat; the huge clumps of heads seen on the show bench are not encountered in the harsh, natural environments of these plants. Conversely, the larger growing, hard-bodied species are very slow growing and it is rare to find plants grown from seed in cultivation that even begin to approach the dimensions of the mature specimens that occur in habitat. Flowering the soft-bodied species is no problem, and they can be relied upon to perform regularly throughout our summer. At the other end of the spectrum, *C. solaris*, *C. cinerea* var. *krainziana*, and *C. cinerea* var. *longistaminea* are difficult to flower in the UK. Only once in 25 years have I persuaded an old imported plant of *C. cinerea* var. *krainziana* to flower. All the others will oblige occasionally — particularly the more southerly occurring species.

Soil

Any good cactus soil will suit these plants, but I avoid peat-based mixes because, although the plants will grow in it for a while, the texture soon deteriorates and then they suffer. For most cacti I prefer a mix of loam-based compost, peat and gravel in roughly equal parts, but for copiapoas I recommend increasing the gravel, resulting in a mix of one part peat, one part loam-based compost, and two parts gravel.

Some species have tuberous roots, which must be protected from stagnant moisture, so these in particular need good drainage, with plenty of air in the soil. The soil must not become alkaline, a pH of around 6 is ideal, and this can be achieved with the above soil mix and subsequent watering with rain water.

Water

I believe that rain water is the best water to use for most cacti, with the regular addition of low nitrate fertilizer during the summer months. In recent years I have given my copiapoas a light, overhead watering over the whole plant in the evening, rather than soaking the soil; I have done this every few days in warm weather, occasionally at other times, and even a little in the winter. The soil just gets moist in the surface layer, but the whole soil mass does not get wet. This attempt at simulating the natural misting they get in habitat seems to have produced good results. I still water the soil sometimes, particularly for the smaller growing, soft-bodied species and young plants, since they can soon dry out and shrivel in hot weather.

Feeding

I believe that we generally underfeed our cacti when we grow them in pots, but whereas I would use a full nitrate feed for vigorous cacti, I think a high potash, low nitrate feed is best for copiapoas. It should be incorporated in the water at full strength about once a month in summer. Use a brand which includes trace elements; these are vital for healthy growth, the lack of them can cause growing-point blindness in copiapoas.

Light

It is tempting to think that copiapoa will stand any amount of sunshine we can give them, but that is a dangerous assumption. At the beginning of the growing season, when they are still dormant, a clear sunny day can badly scorch a plant left near to the glass or in an unventilated glasshouse. I assume that this happens because of hot, stagnant air. There is always a breeze in the wild, and actually it gets quite windy in the afternoons after the mist has cleared. So hot sunshine and still air is to be avoided, particularly before the plants start to grow in March or April, or when they have been moved or turned round. Scorch can scar a plant for years and once done is permanent, being hidden only after many years when the plant has grown enough for the scars to be buried.

Having said that, these plants still need a sunny position in order to keep their natural shape and spination, particularly the hard-bodied species. In nature, some of these, like *C. cinerea*, develop a white waxy bloom on the stems, which gives them a most attractive appearance. Even in the best environment we can provide, this is only slightly developed on cultivated plants in Europe. I assume that lack of light intensity is the reason, since cultivated plants in southern California are almost as white as those in habitat.

Temperature

All *Copiapoa* species are reasonably tolerant of low winter temperatures, 5°C (40°F) being suitable if the plants are dry. I prefer to maintain a slightly higher temperature and give them a light overhead watering in the winter which keeps them more turgid and the growing season can start a little earlier. In their natural habitat some can experience occasional ground frosts at night, but even then the daytime temperature can rise considerably, in contrast to many winter days in a European glasshouse.

Although daytime temperatures in the Atacama can be high, particularly on cloudless days, the wind from over the cold sea, which is at its strongest in the afternoon, tends to cool the plants. It is therefore desirable to ventilate glasshouses as much as possible on sunny days to avoid still, hot air.

Potting

In common with most globular cacti, the fibrous-rooted species are best potted in shallow pans to avoid the potential for a large mass of wet compost remaining below the plant. Those with tuberous roots need deep pots for best results, although I have some experience of removing the tuberous root from bigger specimens, which has resulted in the production of a good, fibrous root system from the bottom of the plant and subsequent, normal growth of the plant body.

Pests

Maintaining clean conditions in your glasshouse is a good way to minimise the chance of pest infestations. Any remains of dead leaves or plants should be removed from the glasshouse, the floor area should be kept clean, and all structural parts regularly disinfected. Pots need to be washed before re-use, and soil should never be re-used for potting. Give all newly acquired plants a clean pot with new soil so that you reduce the chance of introducing pests; an added benefit of this is that all your plants are in the same soil mix and will therefore require the same treatment in cultivation.

The most troublesome pest of copiapos is mealy-bug which does its usual trick of building up numbers behind the plant and in between the offsets so that by the time you notice it, you have an epidemic! As well as marking the plant body, the affected area can develop a black deposit. In severe cases in summer, removal from the pot, a wash with a jet of water and a soak in insecticide is necessary, but otherwise a series of insecticide sprays will do. I used to just treat plants which I could see were infected, but having been caught out a few times, I now soak everything with a rotation of insecticides throughout the summer, and this has reduced the problem dramatically.

Root mealy-bugs are more difficult to detect but are obvious when you repot a plant, and can sometimes be suspected if the plant fails to grow properly. They are best dealt with by drenching the roots with insecticide, either when watering or while the plant is out of the pot.

The pest I fear most is red spider mite, which can quickly destroy the epidermis of a healthy plant, causing damage which can be fatal or take years to grow out. Fortunately, the hard-bodied species of *Copiapoa* do not seem to suffer from this pest, but the soft-bodied forms of *C. humilis* are quite susceptible to it and must be protected by regular inspection and occasional spraying with a suitable acaricide. This pest is said to thrive in hot, dry conditions, so my earlier advice about overhead watering on summer evenings should help to dissuade them.

Seedlings of all cacti are at risk from the larvae of sciara flies, particularly later in the growing season. The small, black flies can be seen moving slowly near the soil surface where they lay their eggs, which hatch into the harmful larvae. They are attracted by rotting vegetable matter, and peat-based soils, and once the larvae are in the soil they can eat roots of plants and even whole seedlings, leaving just the skin behind. They also allow fungal infections to enter the plants they attack, so that even mature plants may be killed. The flies can be treated with an insecticide spray and a drench of the soil with a suitable insecticide can kill the larvae, but they can be elusive and several treatments may be necessary. The flies can enter the glasshouse from the garden or be introduced in soil, so constant vigilance is necessary.



Fig. 15 Habitat of *C. cinerea*, 6km east of Taltal

CHECKLIST OF COPIAPOA NAMES

Bold type indicates species and varieties accepted in this book.

<u>Name</u>	<u>Accepted Name</u>
<i>C. albispina</i> Backbg. nom. nud.	<i>C. cinerea</i> var. <i>gigantea</i>
<i>C. alticostata</i> Ritter	<i>C. coquimbana</i>
<i>C. applanata</i> Backbg.	<i>C. cinerascens</i>
<i>C. atacamensis</i> Middleditch	
var. <i>calderana</i> Hoffmann	<i>C. calderana</i>
<i>C. barquitenensis</i> Ritter nom. nud.	<i>C. hypogaea</i>
<i>C. boliviana</i> (Pfeiffer) Ritter	<i>C. atacamensis</i>
<i>C. bridgesii</i> (Pfeiffer) Ritter	<i>C. marginata</i> var. <i>bridgesii</i>
<i>C. calderana</i> Ritter	
var. <i>spinosior</i> Ritter	<i>C. calderana</i>
<i>C. carrizalensis</i> Ritter	<i>C. cinerea</i> var. <i>dealbata</i>
var. <i>gigantea</i> Ritter	<i>C. cinerea</i> var. <i>dealbata</i>
<i>C. chaniaralensis</i> Ritter	<i>C. humilis</i> var. <i>taltalensis</i>
<i>C. cinerascens</i> (Salm-Dyck) Br. & R.	
var. <i>applanata</i> (Ritter) Hoffmann	<i>C. cinerascens</i>
var. <i>intermedia</i> (Ritter) Hoffmann	<i>C. cinerascens</i>
var. <i>grandiflora</i> (Ritter) Hoffmann	
<i>C. cinerea</i>	
var. <i>albispina</i> Ritter	<i>C. cinerea</i> var. <i>gigantea</i>
var. <i>carrizalensis</i> (Ritter) Hoffmann	
fa. <i>gigantea</i> (Ritter) Hoffmann	
var. <i>columna-alba</i> (Ritter) Backbg.	
var. <i>dealbata</i> (Ritter) Backbg.	
var. <i>eremophila</i> (Ritter) Hoffmann	<i>C. cinerea</i> var. <i>gigantea</i>
var. <i>gigantea</i> (Backbg) Taylor	
var. <i>haseltoniana</i> (Backbg) Taylor	<i>C. cinerea</i> var. <i>gigantea</i>
var. <i>krainziana</i> (Ritter) Slaba	
var. <i>longistaminea</i> (Ritter) Slaba	
var. <i>tenebrosa</i> (Ritter) Hoffmann	<i>C. cinerea</i>
<i>C. columna-alba</i> Ritter	<i>C. cinerea</i> var. <i>columna-alba</i>
<i>C. conglomerata</i> (Philippi) Lembcke	<i>C. solaris</i> (?)
<i>C. coquimbana</i> (Karw. ex Ruempler) Br. & R.	
var. <i>alticostata</i> (Ritter) Hoffmann	<i>C. coquimbana</i>
var. <i>armata</i> Ritter	<i>C. coquimbana</i>
var. <i>fiedleriana</i> (Schumann) Hoffmann	
var. <i>pendulina</i> (Ritter) Hoffmann	<i>C. coquimbana</i>
var. <i>pseudocoquimbana</i> (Ritter) Hoffmann	<i>C. coquimbana</i>

<u>Name</u>	<u>Accepted Name</u>
var. <i>vallenarensis</i> (Ritter) Hoffmann	C. coquimbana
var. <i>wagenknechtii</i> Ritter	C. coquimbana
<i>C. cuprea</i> Ritter	C. echinoides
<i>C. cupreata</i> (Poselger ex Hildmann) Backbg.	C. coquimbana var. fiedleriana (?)
<i>C. dealbata</i> Ritter	C. cinerea var. dealbata
<i>C. desertorum</i> Ritter	C. rupestris
var. <i>hornilloensis</i> (Ritter) Hoffmann	C. rupestris
var. <i>rubriflora</i> (Ritter) Hoffmann	C. rupestris
var. <i>rupestris</i> (Ritter) Hoffmann	C. rupestris
<i>C. dura</i> Ritter	C. echinoides
<i>C. echinata</i> Ritter	C. megarrhiza var. echinata
var. <i>borealis</i> Ritter	C. megarrhiza var. echinata
C. echinoides (Lemaire ex Salm-Dyck) Br. & R.	
var. <i>cuprea</i> (Ritter) Hoffmann	C. echinoides
<i>C. eremophila</i> Ritter	C. cinerea var. gigantea
<i>C. esmeraldana</i> Ritter	C. humilis var. esmeraldana
<i>C. ferox</i> Lembcke & Backbg. ex Backbg. nom. inval.	C. solaris
<i>C. fiedleriana</i> (Schumann) Backbg.	C. coquimbana var. fiedleriana
<i>C. gigantea</i> Backbg.	C. cinerea var. gigantea
<i>C. grandiflora</i> Ritter	C. cinerascens var. grandiflora
<i>C. haseltoniana</i> Backbg.	C. cinerea var. gigantea
<i>C. hornilloensis</i> Ritter	C. rupestris
C. humilis (Philippi) Hutchison	
var. esmeraldana (Ritter) Hoffmann	
var. longispina (Ritter) Hoffmann	
var. <i>paposoensis</i> (Ritter) Hoffmann	C. humilis
var. taltalensis (Werd.) Hoffmann	
var. tenuissima (Ritter) Charles	
var. tocopillana (Ritter) Charles	
var. varispinata (Ritter) Charles	
C. hypogaea Ritter	
var. <i>barquitensis</i> Ritter	C. hypogaea
var. laui (Diers) Hoffmann	
var. montana (Ritter) Charles	
<i>C. krainziana</i> (Ritter)	C. cinerea var. krainziana
var. <i>scopulina</i> Ritter	C. cinerea var. krainziana
<i>C. lembcke</i> Backbg. nom. inval.	C. calderana
<i>C. laui</i> Diers	C. hypogaea var. laui
<i>C. longispina</i> Ritter	C. humilis var. longispina
<i>C. longistaminea</i> Ritter	C. cinerea var. longistaminea
<i>C. malletiana</i> (Lemaire ex Salm-Dyck) Backbg.	Known only by a poor description so best ignored.

<u>Name</u>	<u>Accepted Name</u>
C. marginata Br. & R. var. bridgesii (Pfeiffer) Hoffmann	
C. megarhiza Br. & R. var. echinata (Ritter) Hoffmann var. microrhiza Ritter	C. megarhiza
<i>C. melanohystris</i> Ritter	C. cinerea var. columna-alba
' <i>C. minima</i> ' nom. nud.	C. cinerea form
<i>C. mollicula</i> Ritter	C. hypogaea
<i>C. montana</i> Ritter	C. hypogaea var. montana
<i>C. olivana</i> Ritter	C. hypogaea var. montana
<i>C. paposoensis</i> Ritter	C. humilis
<i>C. pendulina</i> Ritter	C. coquimbana
<i>C. pepiniana</i> (Lemaire ex Salm-Dyck) Backbg. var. fiedleriana Backbg.	Probably not a <i>Copiapoa</i>
<i>C. pseudocoquimbana</i> Ritter var. chaniarensis Ritter var. domeykoensis Ritter var. vulgata Ritter	C. coquimbana var. fiedleriana
<i>C. rarissima</i> Ritter	C. coquimbana
<i>C. rubriflora</i> Ritter	C. coquimbana
C. rupestris Ritter	C. coquimbana
' <i>C. scopulina</i> ' Ritter nom. nud.	C. coquimbana
<i>C. serenana</i> Voldan	C. hypogaea var. montana
C. serpentisulcata Ritter var. castanea Ritter	C. rupestris
C. solaris (Ritter) Ritter	
<i>C. streptocaulon</i> (Hook.) Oosten	C. cinerea var. krainziana
<i>C. taltalensis</i> (Werd) Looser	A single plant of unknown affinity
<i>C. tenebrosa</i> Ritter	C. serpentisulcata
<i>C. tenuissima</i> Ritter	
<i>C. tocopillana</i> Ritter	C. marginata
<i>C. totoralensis</i> Ritter	C. humilis var. taltalensis
<i>C. vallenarensis</i> Ritter	C. cinerea
<i>C. varispinata</i> Ritter	C. humilis var. tenuissima
' <i>C. wagenknechtii</i> ' Ritter nom. nud.	C. humilis var. tocopillana
	C megarhiza var. echinata
	C. coquimbana
	C. humilis var. varispinata
	C. coquimbana

COMMENTARY ON SPECIES — CONTENTS

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Fig.16

Habitat-collected plants of *Copiapoa cinerea* in cultivation at DeHerdt's nursery in Belgium in 1972

Copiapoa atacamensis

Copiapoa atacamensis Middleditch, *Chileans* 11(37):21 (1980)

This name was applied by Harry Middleditch in 1980 to the plant found near Antofagasta which had for so long been thought to be *Echinocactus marginatus* collected by Thomas Bridges (see under *C. marginata*). He chose as the type a plant collected by Rose in 1914 in the coastal hills around Antofagasta. Initially, Ritter had also used the name *C. marginata* for this plant, but in Vol. 3 of his *Kakteen in Südamerika* he accepted that the plants from south of Caldera were the true *C. marginata*. His solution to the lack of name of the Antofagasta plants was to call them *Copiapoa boliviana*, based on the Pfeiffer description of *Echinocactus bolivianus* from 1847, also based on a plant collected by Bridges. The original description is rather vague and although it may well refer to a species of *Copiapoa*, it is unlikely that Bridges collected this species, so a more southerly occurring species is more likely. In fact, in 1850 Pfeiffer himself reduced *Echinocactus bolivianus* to synonymy under *E. echinoides*, so *Copiapoa atacamensis* remains the best choice as the valid name for this plant.

The English description from *Chileans* No. 37 (1980) reads: "Globular to somewhat elongated-globular, solitary or clumping with 5 to 8 (–9) heads. Body up to 12cm in diameter, grey-green covered with grey-white coating. Ribs becoming 12–16, obtuse to acute, upright to slightly spiralling, with well-defined acute to obtuse groove between base of ribs. Top of ribs more or less rounded, barely divided into tubercles by slight depressions between areoles. Adjacent areoles usually touching but may be up to 15mm apart. Young areoles 6–8mm diameter, covered with soft orange-brown hairs which obscure the growing point, then becoming black and finally appearing to be almost bare. Outer spines 5–7, radiating, projecting

Fig.17
Copiapoa atacamensis
in habitat at Cerro
Moreno



markedly, curved backwards slightly, 10–12mm long, the lowest often the longest, together with an occasional one or two short, slender, almost bristle-like spines from the upper part of the areole; central spine one, straight, projecting outwards, 33–38mm long, round, tapering, some 1mm diam. at the base. All spines are chestnut brown in apex, rapidly becoming grey-black and then grey. Flowers and fruit not yet known. Type locality: coastal hills around Antofagasta, north Chile. Type plant: Rose 19410 in New York Botanical Garden Herbarium.”

It is now confirmed that the number of heads can actually be many more than nine, and the flowers and fruits are known to be much like those of most other copiapoas (Fig.18).

The habitat range of this species is from between Paposo and Blanco Encalada in the south to Cerro Moreno in the north. The plants are abundant in the coastal hills near Morro Moreno and down to sea level at La Chimba. In the south at Blanco Encalada, *C. atacamensis* occurs among rocks in the ravines of the coastal hills. It bears a superficial resemblance to *C. calderana*, from the north of Caldera, which Hoffmann regards as a variety of this species, but their considerable geographic separation leads me to retain them as different species. They are easily distinguished when one is familiar with both plants, and *C. calderana* becomes more columnar with age.

As this part of Chile becomes drier, the ability of these plants to produce seeds is reduced so that habitat seed is rarely offered for sale. Most plants in collections are habitat-collected specimens, many sent to Europe by Karel Knize (see the introduction to the section on Field Collectors' Numbers) under various incorrect names including *C. marginata* and *C. tocopillana*. They flower easily once mature enough to do so — usually after about 10 years when grown from seed in northern Europe.

Fig.18
Copiapoa atacamensis
in cultivation,
ex habitat, KK



Copiapoa calderana

Copiapoa calderana (Ritter), Cactus (Paris) 14(65):197-8 (1959)

Synonyms: *C. lembckei* Backbg. (1959) nom. inval.; *C. calderana* var. *spinosior* Ritter (1980); *C. atacamensis* var. *calderana* Hoffmann (1989)

This beautiful species can be found growing near the coast north of Caldera, mainly as solitary specimens, but further north large clumps are more common. It was first described by Ritter in 1959, but plants in cultivation are more often seen under the invalid Backeberg name of *C. lembckei*. Hoffmann (1989) reduced this species to a variety of *C. atacamensis* from the far north, to which it bears a superficial resemblance, but that combination is not adopted here because of the geographical separation.

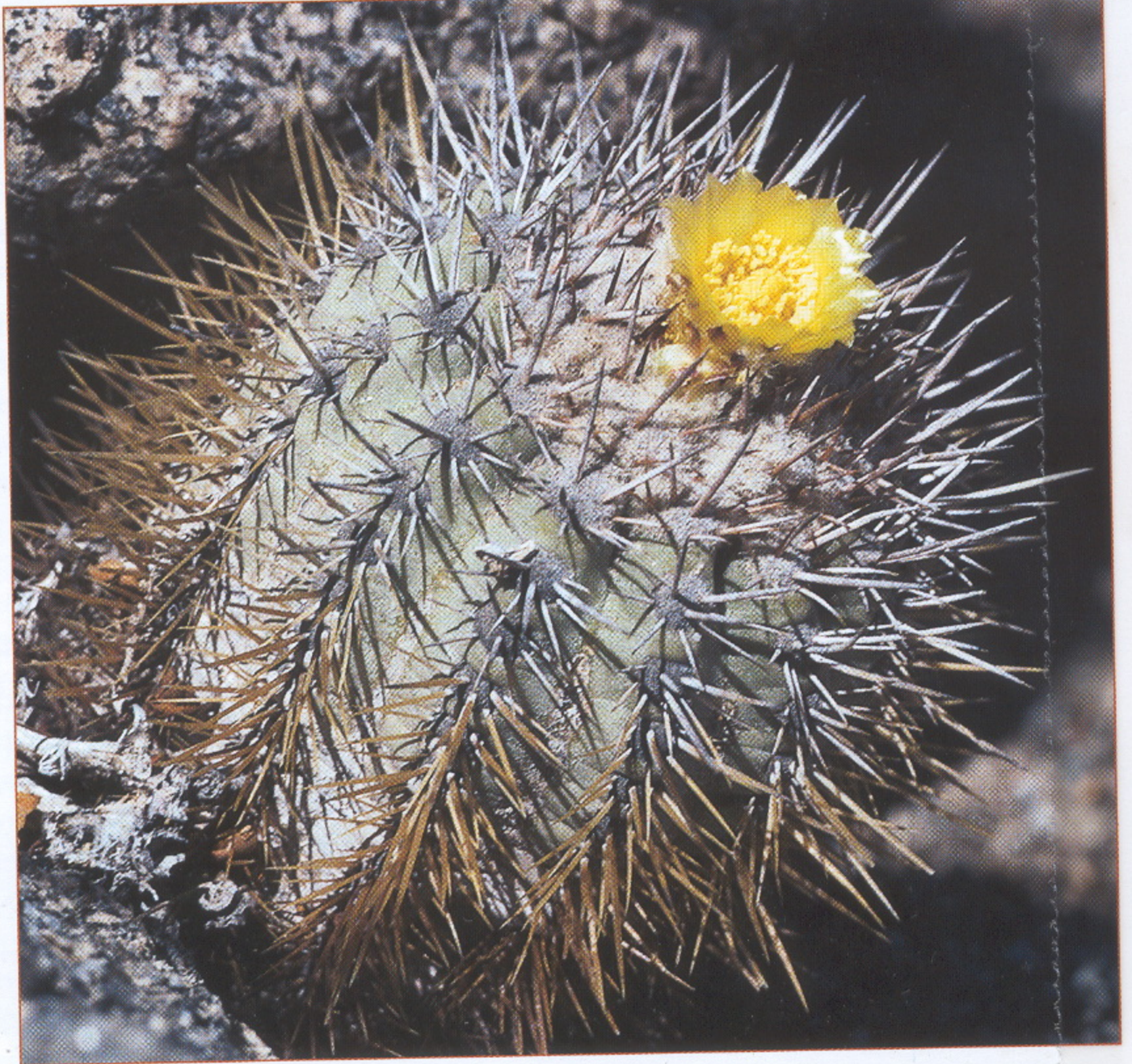
Part of Ritter's description, in translation, reads: "Body: solitary or loosely clumping, globular, later elongated, 5–10cm thick, bright grey-green,

without white frosting, with long thin hard tuberos root with very narrow stem, which breaks off easily, with grey woollen crown. Ribs: 10–17, wide and blunt, 6–10mm high, virtually no notches or humps, divided by humps in seedlings. Areoles: grey, black in age, 4–7mm diameter, round, when ribs are slightly notched then areoles sit in notches, 3–7mm apart. Spines: thin needle shaped awl-like to thick needle shaped, straight or nearly straight, black or brown, turning grey. 4–7 radial spines, 10–15mm long, lower ones longest; one, rarely two central spines, 15–30mm long. Flower: (4 flowers studied on several different specimens) scented, 25–35mm long, opening a similar amount, above the ovary, a slight constriction on the outside. Nectar chamber 2–3mm high,



Fig.19 *Copiapoa calderana* in habitat 21km north of Caldera, GC 121.01

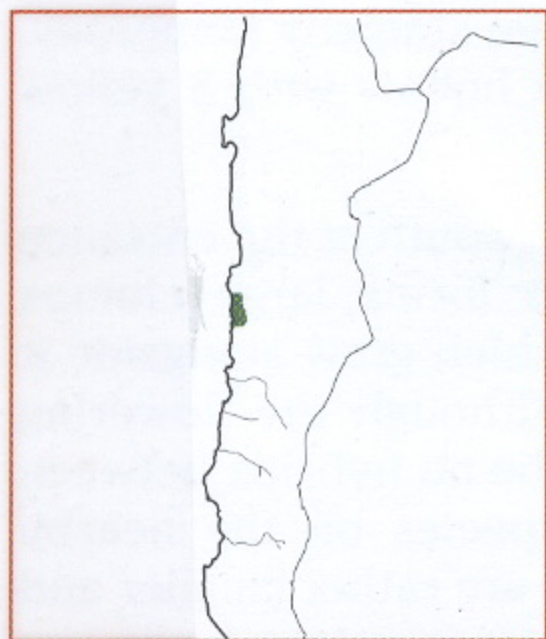
Fig.20
Copiapoa calderana in
habitat 11.5km north
of Caldera, GC 120a.01



3–4mm wide, half open. Receptacle: pale yellow-green above with a few large reddish-brown scales, funnel-shaped, 6–9mm long, 10–12mm wide at top.”

Many plants of this species were imported in the 1970s under the name *C. lembckeii* and these proved quite easy to establish, although the bodies tend to elongate a little in cultivation. The large tap root had in most cases been removed, but a fibrous root system usually established without difficulty. Seed is rarely offered, but when it is the seedlings soon make attractive plants, requiring spacious pots to accommodate the large roots. The imported plants flower easily but seedlings raised in cultivation take at least 10 years to reach flowering size, by which time they will generally be in approximately 10cm diameter pots.

Fig.21 *Copiapoa calderana*
in cultivation, ex habitat, Lau



Copiapoa cinerascens

Copiapoa cinerascens (Salm-Dyck) Br. & R., The Cact. III:88 (1922).
Basionym: *Echinocactus cinerascens* Salm-Dyck (1845)

Synonyms: *Echinocactus copiapensis* Pfeiffer (1847); *Copiapoa applanata* Backbg. (1959); *C. cinerascens* var. *applanata* Ritter (1980); *C. cinerascens* var. *intermedia* (Ritter) 1980

One of the earliest species to be described by Salm-Dyck in 1845, the description is not precise enough to be sure that Ritter's application of the name to a plant growing north of Chañaral is correct. Although Ritter's plant matches the original description reasonably well, the area where it grows is north of where Bridges is believed to have travelled, and the species was described by Salm-Dyck from material collected by him. The habitat range is from south of Barquito (Ritter's variety *intermedia*) to north of Chañaral, where in this part of its range it grows just in the southern part of Pan de Azucar National Park in the company of

C. serpentisulcata and *C. cinerea* var. *columna-alba*. If you include *C. grandiflora* with this species, then the range extends just to the north of the park to Esmeralda.

The original description as republished in English by Taylor reads: "Stem depressed-globose, c. 9cm. diam., greyish dirty green, convex and grey-woolly at apex; ribs 20, narrow, sub-compressed, tuberculate, indented between the areoles; areoles crowded, roundish, c. 6–9mm apart, with grey or blackish felt; rad. sp. 8, 10–13mm. long, lower ones longest, spreading and intertwined; central spines 2, 18–21mm long; all spines very rigid, at first blackish, then ash grey. Flower medium sized, yellow, surrounded by spines; lowermost perianth segments narrowly lanceolate, upper ones broader and red at the tip, recurved; inner perianth segments

cinerascens
var. cinerascens



Top Fig.22
Copiapoa cinerascens in cultivation, ex habitat, Lau
Bottom Fig.23
Copiapoa cinerascens in habitat 8km north of Chañaral, GC 124.01

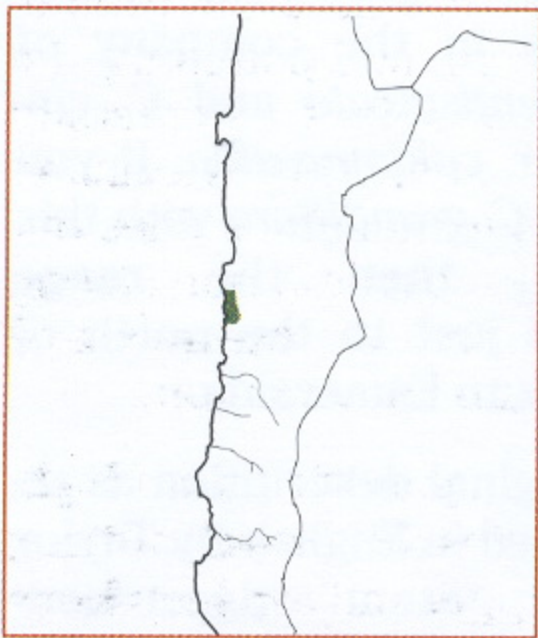
broadly lanceolate, erect, acute, margin denticulate; stamens numerous, grouped together, anthers yellow; style thick and hollow with 8 yellow stigmas."

Near to the shore at the foot of the coastal hills, just south of the entrance to Pan de Azucar National Park, *C. cinerascens* forms large clumps remarkably similar to those of *C. serpentisulcata* which grow alongside it on this gently sloping extension of the beach. Although the flowering periods of the two species overlap, there seem to be no hybrids between the two, nor with any of the other Copiapoa species on the nearby hillside. Further north, inside the park, the clumps are rather smaller and can be found dotted amongst a 'forest' of *C. cinerea* var. *columna-alba*.

In the southern part of its distribution can be found a smaller form which makes flat clusters, named by Ritter as *C. cinerascens* var. *intermedia*, but this is the same plant as Backeberg's *C. applanata* — both of these are here considered synonyms of *C. cinerascens*.

Copiapoa cinerascens var. *grandiflora* (Ritter) Hoffmann
Basionym: *Copiapoa grandiflora* Ritter (1963)

The most northerly occurrence of this species is in the guise of Ritter's *C. grandiflora* at Esmeralda, the commonest form in cultivation, popular because of its readiness to produce its large flowers — perhaps the largest in the genus. *C. cinerascens* var. *grandiflora* also forms clumps, although smaller than the plants further south.



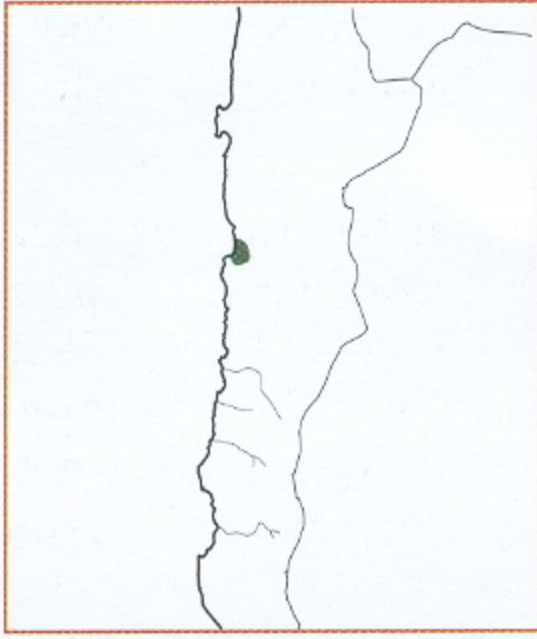
cinerascens
var. *grandiflora*



All the forms of *C. cinerascens* have large tuberous roots which make habitat-collected plants difficult to accommodate in pots, and seedlings appreciate plenty of space for the roots to develop. Plants of *C. cinerascens* var. *cinerascens* grown from seed collected by Ken Preston-Mafham in 1987 just north of Chañaral have proven easy to cultivate and are already beginning to clump at 10 years of age, growing in 10cm pots.

Top Fig.24 *C. cinerascens* var. *grandiflora* in cultivation, from habitat seed, PM 209

Bottom Fig.25 *Copiapoa cinerascens* var. *grandiflora* in habitat at Esmeralda, GC 129.02



Copiapoa cinerea

Copiapoa cinerea (Philippi) Br. & R., The Cact. III:86 (1922)

Basionym: *Echinocactus cinereus* Philippi (1860)

Synonyms: *Copiapoa tenebrosa* Ritter (1980); *C. cinerea* var. *tenebrosa* (Ritter) Hoffmann (1989)

An extremely variable species in its many varieties and forms, *C. cinerea* embraces the most desirable characteristics of all copiapoas. Many names have been given to its various forms, but because of the nature of the terrain it is not easy to determine if they warrant varietal status. I have retained a number of these names as varieties in this account as an easy way to retain their individuality because of the desirability of each in cultivation.

Echinocactus cinereus was found by Philippi in 1854 and first described by him in 1860 from a place called Hueso Parado, which is inland from Taltal. The plants found around there today have black spines, matching the original description, but have a variable number of spines — diversity which is represented in the original type collection. The Schumann illustration of 1903 shows a plant with one or two short central spines but no radials, a form which can be found, but is not the most common among the population at the type locality. Most plants have two centrals and some radial spines, as stated by Philippi in his original description.

The description in Britton and Rose reads: "Simple, cylindric, 20cm high, 10cm in diameter, covered with wool at the apex; ribs 18, broad, obtuse; spines solitary or sometimes 5 or 6, terete, black; upper radials 4mm long;

cinerea
var. cinerea

Fig.26

Copiapoa cinerea in
habitat 6km east of
Taltal, GC 134.01





Fig.27
Copiapoa cinerea in
habitat 6km east of
Taltal, GC 134.01

lower radials 12 to 16mm long; central spine 18 to 20mm long; flowers funnel-form, 18 to 30mm long, 2.5cm broad, yellow; ovary naked; fruit 1.5 to 2cm long; seeds black and shining.”

The excellent article by Paul Hutchison in the US Journal (1953) adds to this incomplete description. The plants at the type locality are not always solitary in maturity, and they get significantly bigger than stated by Britton & Rose. Hutchison says that most plants are columnar to 1.3 metres tall, usually single or with 1 to 5 branches commonly from the base. The number of ribs varies at least from 14 to 30, the number being dependant on the age and size of the stem — the oldest stems in the most favourable locations having the greatest number of

ribs. The epidermis of all specimens in this area is ash-grey and the spines black. He further states that the populations near the coast have longer, thinner spines of a pale brown or yellow colour. This phenomenon has also been reported recently in other species by Atilla Kapitany (1996).



Fig.28
Copiapoa cinerea in
habitat 6km east of
Taltal, GC 134.01



Fig.29

Cylindropuntia cinerea in cultivation,
18 years old, raised from habitat seed

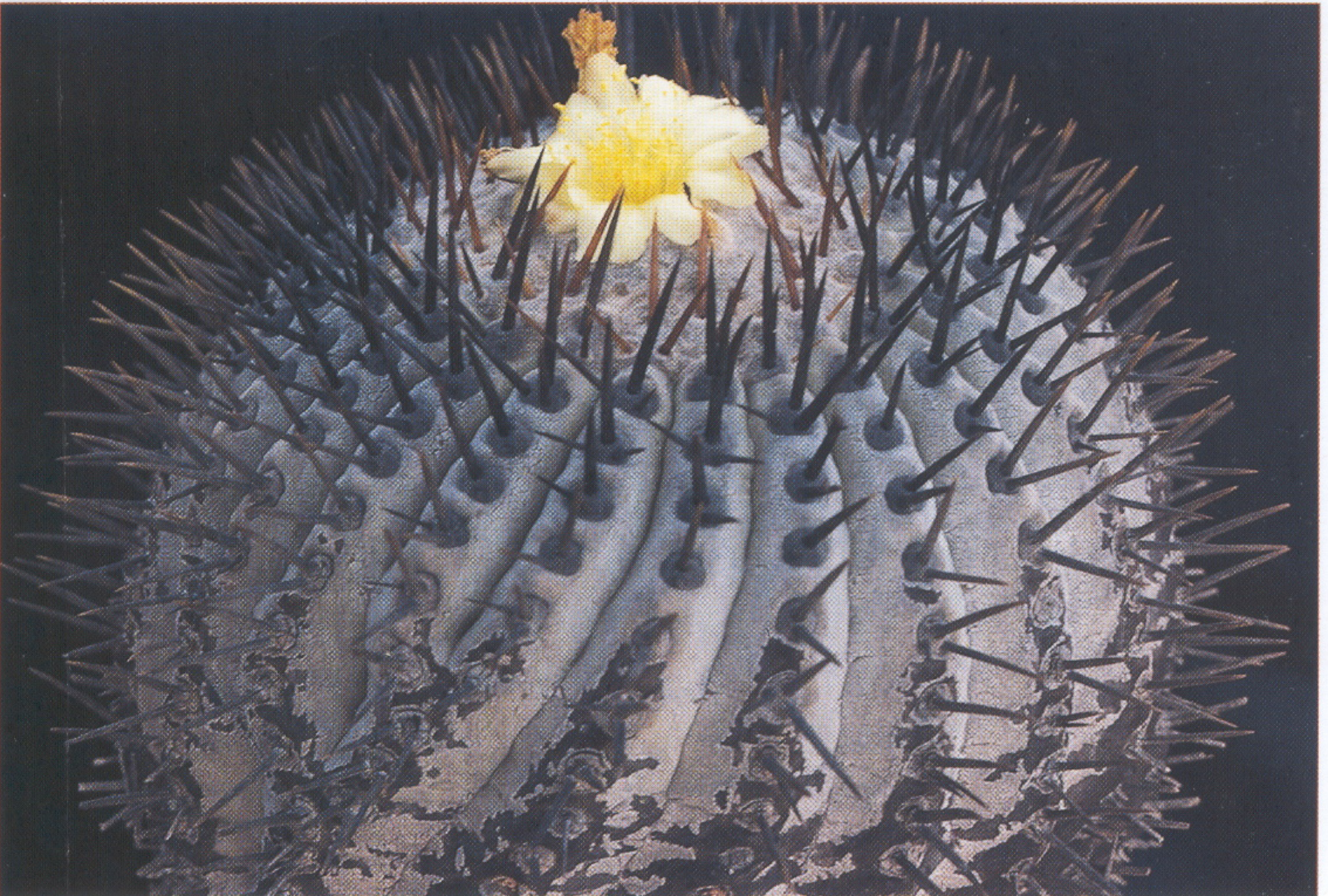
Fig.30

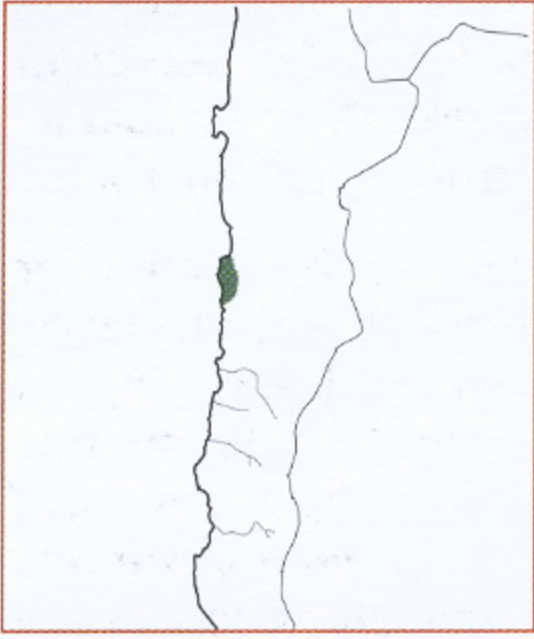
Cylindropuntia cinerea in cultivation,
ex habitat, RMF 152

I saw this wonderful plant near to Breas, growing on the slopes at the side of the main road leading into Taltal from the south, where it was plentiful and as diverse as the above description makes clear. The plants were much bigger and more columnar than I had expected — obviously the imported plants I had seen in the 1970s were comparatively young. Indeed, perhaps the absence of small plants near the road was due to the collection and export of plants in the past. For the cactus collector this must be one of the most desired plants from South America: the contrast of the black spines against the white body is irresistible. Cultivated seedlings are very slow growing and in Britain fail to develop the white waxy bloom on the body, rather adopting a brownish hue — still attractive, but not the same! I conclude that it must be the environment, perhaps light intensity, which stimulates the development

of the white coating, since plants in cultivation in California develop it far better.

The Ritter name *C. tenebrosa* can be referred to forms within the variability of this species since it occurs within populations of *C. cinerea* var. *cinerea*. These populations can be found in the mountains to the east of Taltal.





**cinerea var.
columna-alba**

Right Fig.31
Copiapoa cinerea
var. *columna-alba* in
cultivation, ex habitat,
KK 611

Below Fig.32
Copiapoa cinerea
var. *columna-alba*
(*melanohystrix*) in
habitat at Esmeralda,
GC 127.01

Copiapoa cinerea var. *columna-alba* (Ritter) Backbg. Die Cact. 6:3820 (1962). Basionym: *Copiapoa columna-alba* Ritter (1959)

Synonym: *Copiapoa melanohystrix* Ritter (1980)

First described by Ritter as a species in 1959, it was reduced by Backeberg to a variety of *C. cinerea* in 1962. This variety has a very distinctive appearance. The stems are usually solitary, up to nearly one metre high, the top third being a beautiful white with sparse spines, either black or quite pale, and a broad crown filled with orange wool. The bases of the stems are spineless and have a brown-orange covering, which is what is left after the elements remove the waxy coat of the newer growth. The plants occur usually on gentle slopes in localized populations often consisting of a large number of individuals. All the older plants lean markedly towards the north; there are many theories for



this behaviour but I favour the idea that this inclination minimises the exposure to the drying effects of the sun. It is similar to that observed in some *Ferocactus* species. The soil in which the plants grow is often coarse, crystalline sand, but individuals can also be found growing among rocks.

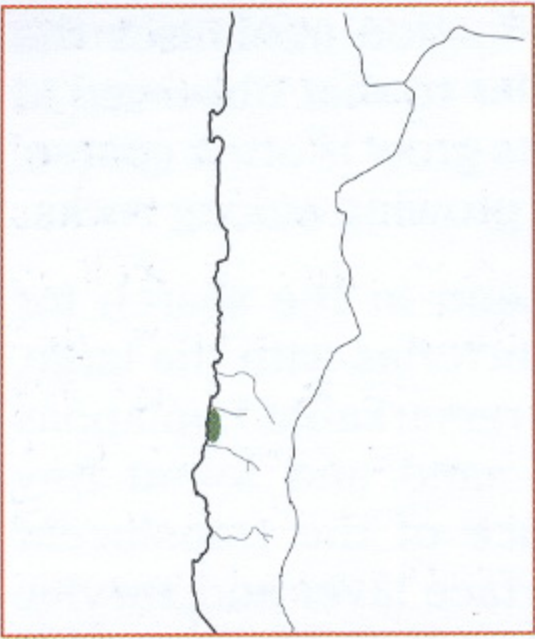
At Esmeralda, while running my hand over the sand in the search for elusive thelocephalas — those small-growing neoporterias with the large, tuberous roots — I chanced upon the way these remarkable copiapos reproduce. I felt spines in among the grains of sand and found tiny seedlings of the *Copiapoa* living below the surface of the translucent grains. It seems that the seeds germinate in the surface layer and survive with the protection of the sand until they are large enough to endure full exposure.

Growing near Esmeralda there is a form of this variety with denser, black spines and a less white epidermis, which was named as *Copiapoa melano-hystrix* by Ritter (1980). Plants of this form seemed to be more prone to the development of a covering of lichen, due perhaps to more fog at this locality. The reported distribution of this variety extends from just north of Chanaral in the south to north of Cifuncho.

In cultivation, *C. cinerea* var. *columna-alba* is very slow to grow from seed but will make a very attractive plant after 10 years or so. Old imported plants flower more readily for me than plants of the type, although I have yet to flower a seedling.

Fig.33
Copiapoa cinerea
var. *columna-alba* in
habitat at Pan de
Azucar, GC 126.02





cinerea
var. dealbata

Copiapoa cinerea var. *dealbata* (Ritter) Backbg., Die Cact. 6:3823 (1962). Basionym: *Copiapoa dealbata* Ritter (1959)

Synonyms: *Copiapoa carrizalensis* Ritter (1959); *C. carrizalensis* var. *gigantea* Ritter (1963); *C. cinerea* var. *carrizalensis* (Ritter) Hoffmann (1989); *C. cinerea* var. *carrizalensis* f. *gigantea* (Ritter) Hoffmann (1989)

This is the most southerly variety of *Copiapoa cinerea* and, because of its size and population density, the most spectacular to see in habitat. Originally described by Ritter in 1959 as *C. dealbata*, it was reduced to a variety of *C. cinerea* by Backeberg in 1962. Included as a synonym is *C. carrizalensis*, also described by Ritter in the same publication in 1959. It may be that *Echinocactus malletianus* described by Salm-Dyck in 1845 could be this plant, since his *Echinocactus echinoides* grows in the same area and both could well have been collected by Bridges. Since there is

considerable doubt about this and, if it were accepted, then the later name *C. cinerea* could end up as a synonym, most authors choose to ignore the name *C. malletiana* as being inadequately typified.

We found the plant near to the sea as we went northwards on the coastal track, first at about 25km north of Huasco Bajo, then as far as about 30km north of Carrizal Bajo. Over relatively small areas, these plants can be the dominant feature of the landscape, forming huge clusters up to three



Top Fig.34 *Copiapoa cinerea* var. *dealbata* in cultivation, raised from habitat seed, RMF 278

Bottom Fig.35 *Copiapoa cinerea* var. *dealbata* in habitat 27km north of Carrizal Bajo, GC 117.04





metres across, which must be an immense age (see back cover). In between these concentrations, the plants become scattered or absent. The degree of development of the white bloom on the bodies varies from one population to another, as well as between individuals. The number of spines also varies, making every plant look just that bit different from its neighbours. (See cover of BCSS Journal, Vol.13, No.1 1995). It shares its habitat with two other copiapoa, *C. megarhiza* var. *echinata* and *C. echinoides*, as well as species of *Eulychnia* and *Trichocereus*.

This is a good plant to grow in cultivation. It is quicker than the other varieties of *C. cinerea* and forms attractive long spines in its second year from seed, followed by the first offsets some years later. The body remains green in northern Europe, failing, even in a full light situation, to develop the white waxy covering. It would take many years to reach flowering size.

Top Fig.36 *Copiapoa cinerea* var. *dealbata cristate* in habitat 17km north of Carrizal Bajo, GC 116.01

Bottom Fig.37 *Copiapoa cinerea* var. *dealbata* in habitat 28km north of Huasco Bajo, GC 114.01





**cinerea
var. gigantea**

Copiapoa cinerea var. *gigantea* (Backbg.) Taylor Bradleya 5:92 (1987)
Basionym: *Copiapoa gigantea* Backbg. in Jahrb. Deutsche Kakteen Ges. 1:104 (1936)

Synonyms: *Copiapoa haseltoniana* Backbg.(1956); *C. albispina* Backbg. nom. nud. (1959); *C. eremophila* Ritter (1980); *C. cinerea* var. *haseltoniana* (Backbg.) Taylor (1981); *C. cinerea* var. *eremophila* (Ritter) Hoffmann (1989); *C. cinerea* var. *albispina* (Ritter) Hoffmann (1989)

As one travels north along the coast road from Taltal to Paposo, the spines of *Copiapoa cinerea* change colour, becoming first white (var. *albispina* [Figs. 41 & 106]), and then golden near to Paposo. The apical wool also varies from grey in the south to orange-brown in the north, with a mixture in the areas between. The golden-spined plants with orange-brown apical wool from north of Paposo were named *C. haseltoniana* by Backeberg in 1956, and reduced to a variety of *C. cinerea* by Taylor in 1981.

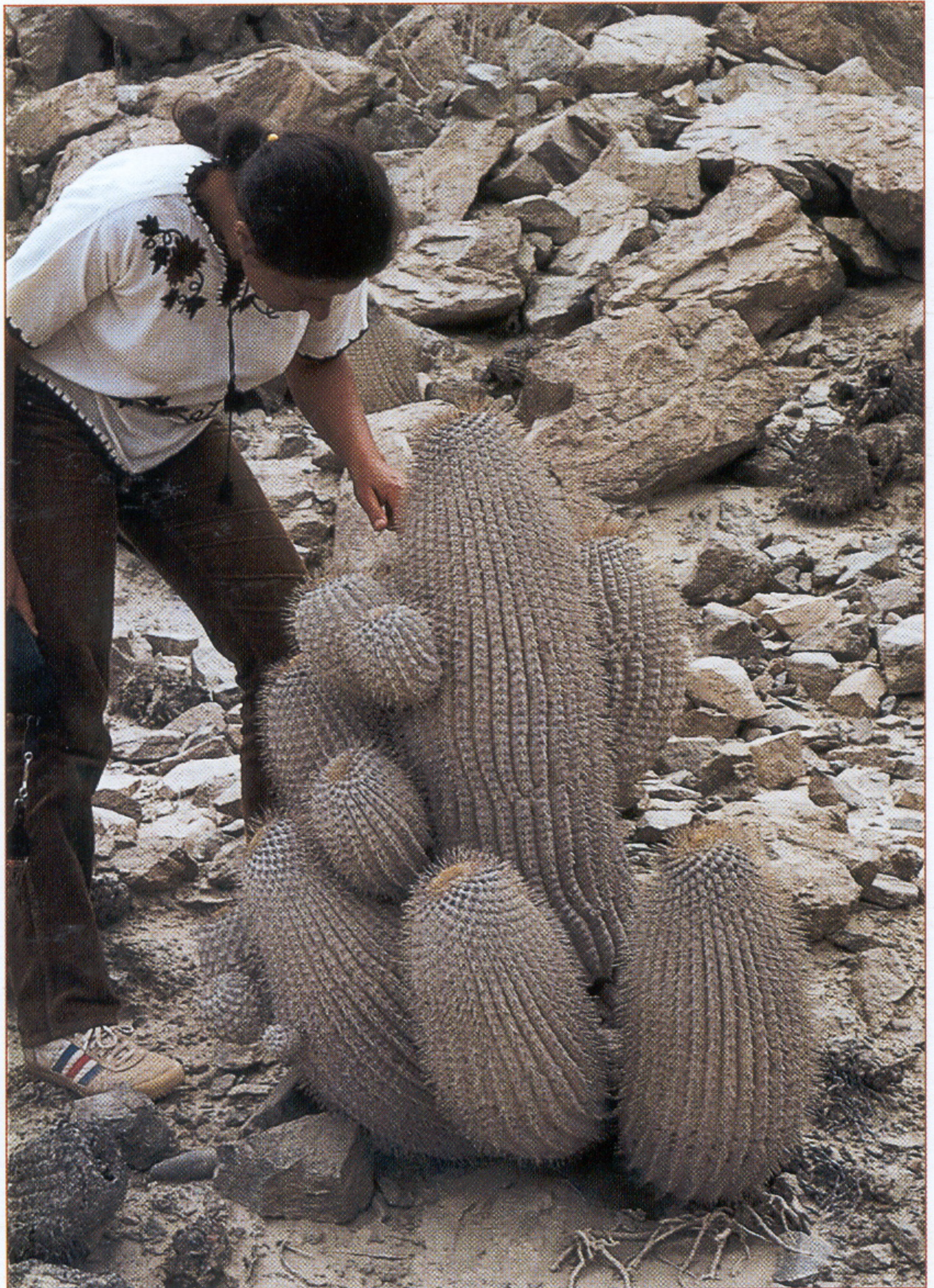


Fig.38
Adriana Hoffmann
admiring *Copiapoa
cinerea* var. *gigantea*
in habitat, 15km south
of Paposo, RMF



Fig.39 *Copiapoa cinerea* var. *gigantea* (*haseltoniana*) in habitat at Paposo near the sea, GC 133.01

The plants in this region are very variable and plants showing different mixtures of characteristics can be found in a small area. At Paposo, near to the sea, I found small-headed freely clumping plants with whitish bodies. On the hills overlooking Paposo there were similar plants, but with much larger bodies, which are probably what Backeberg described as *C. gigantea* in 1936 — I believe that these are forms of the same species showing adaptations to the environment.

The diversity along this stretch of coast has led some authors to speculate about hybrids between *C. cinerea* and *C. gigantea/haseltoniana*, but I think this must be one variable species and even the recognition of *C. gigantea* as a variety is questionable. I follow Taylor here by including it separately because it is distinct in cultivation from *C. cinerea* and is very popular, being seen more often in collections than the type perhaps because of its quicker growth and greater ease of flowering.

The plant described by Ritter as *C. cinerea* var. *albispina* is intermediate in form between *C. cinerea* and *C. cinerea* var. *krainziana*. In habitat, I also saw plants which were intermediate between *C. cinerea* var. *albispina* and var. *krainziana* — another factor which seems to confirm that the latter is a variety of *C. cinerea*.

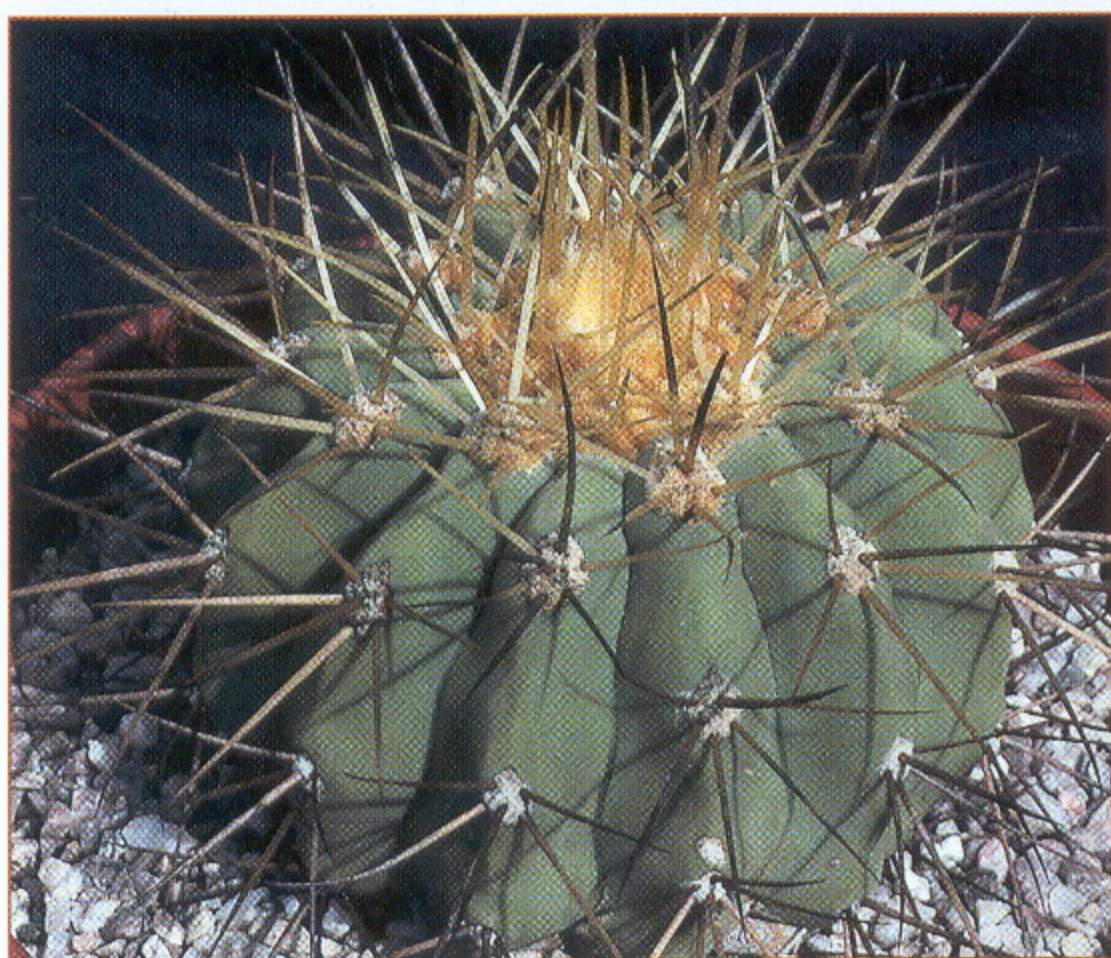


Fig.40 *Copiapoa cinerea* var. *gigantea* (*haseltoniana*) in cultivation, from habitat seed, PM 202

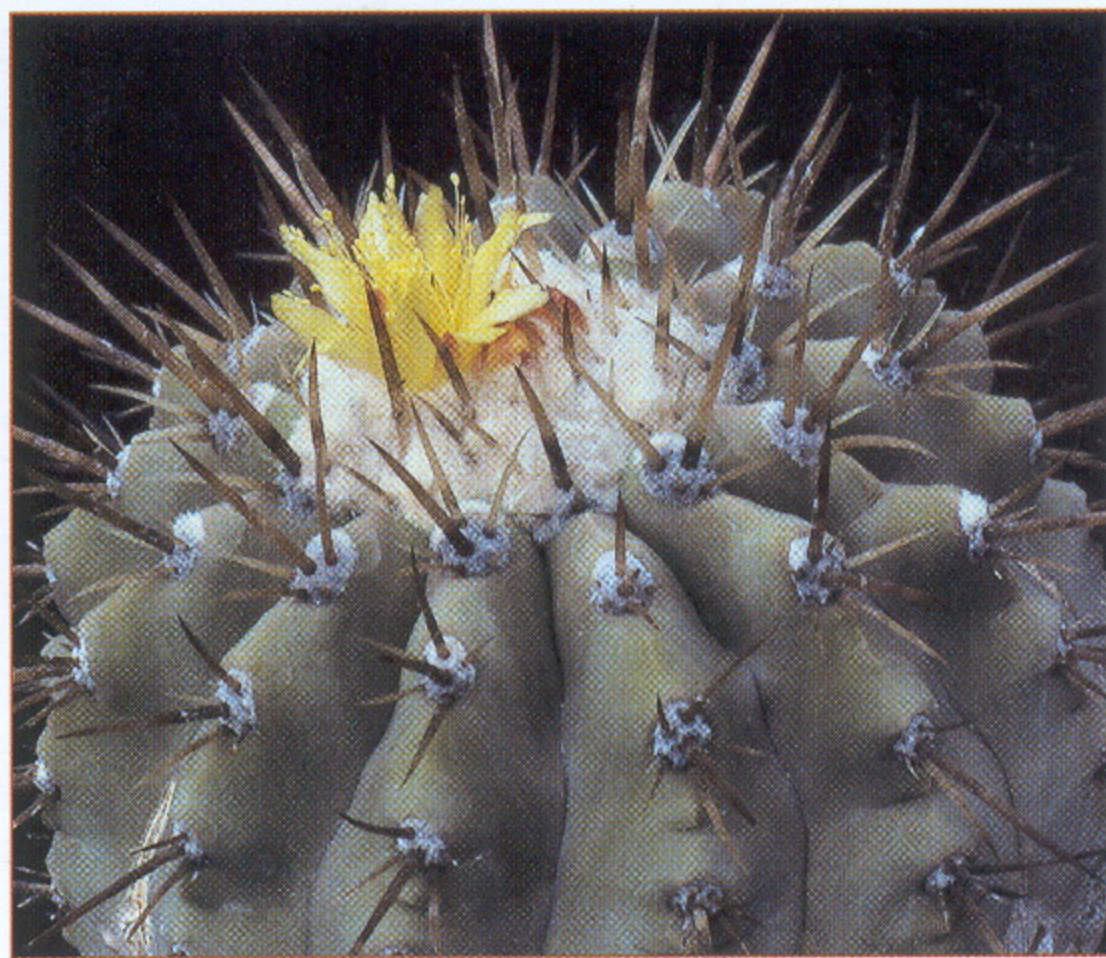
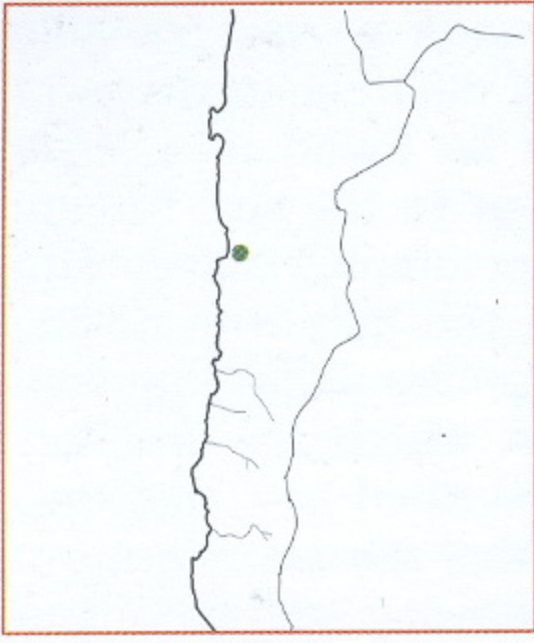


Fig.41 *Copiapoa cinerea* var. *gigantea* (*albispina*) in cultivation, ex habitat, KK



**cinerea
var. krainziana**

Copiapoa cinerea var. *krainziana* (Ritter) Slaba; Kaktusy XXXIII Special p3 (1997). Basionym: *C. krainziana* Ritter in Taxon 12: 30 (1963)

Synonym: *C. krainziana* var. *scopulina* Ritter (1963)

This wonderful variety, with its dense covering of long soft white spines, must be the most easily recognized *Copiapoa*. It can be found growing in the hills north of Taltal. At first, as you walk up the narrow valley called the Quebrada San Ramon, you see a remarkable assortment of characters in the copiapoa. There is every combination of colours in the spines, body and wool, and clustering plants of all shapes and sizes. Previous authors have suggested that these are hybrids between *C. cinerea*, and its varieties *haseltoniana* and *krainziana*. As you climb higher, plants matching Ritter's *C. krainziana* var. *scopulina* can be found among the populations. At around this altitude there are occasional plants of a more densely white-spined form which has often been exported to Europe as *C. krainziana*, but these plants have stiffer, shorter spines than the true *C. cinerea* var. *krainziana* which occurs at a higher altitude.

This plant has long been a favourite of mine, and I remember the day in November 1994 when I was in Chile, walking up a valley and wondering if it was the right one in which to find the plant, and thinking of the reports of *C. krainziana* being extinct in habitat (in hindsight, I can only presume that the author had walked up the wrong valley!). Hours earlier my friends and I had left the car near the coast road and had begun our trek inland in search of this plant, but so far without luck. They decided to call it a day, but I said I would walk for another half an hour, and so I carried on along this twisting valley. Then, twenty minutes later, I rounded a corner and was confronted with a hillside covered with *C. cinerea* var. *krainziana*. You can imagine how I felt, it was like visiting an old friend and finding him at home! The older plants had long stems, only the top covered in soft white

Fig.42
Copiapoa cinerea
var. *krainziana* in
habitat in Quebrada
San Roman, GC 131.02



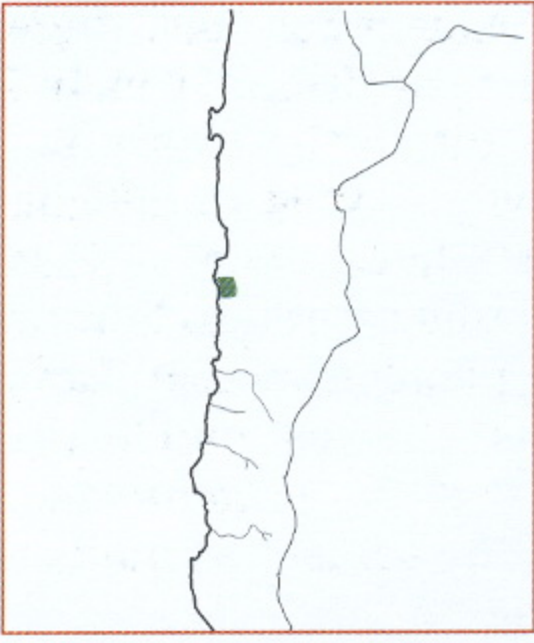
Fig.43
Copiapoa cinerea
var. *krainziana*
in cultivation,
ex habitat, Lau 871



Fig.44
Copiapoa cinerea
var. *krainziana* in
habitat in Quebrada
San Roman, GC 131.02

spines, the lower parts blackened. Some plants actually had black spines mixed in with the white. I am very pleased to report that the population was extensive, and appeared to be healthy although not in flower or fruit — I suspect due to drought. Growing with it was a small, solitary species of *Copiapoa* which I now believe to be a northern form of *C. rupestris*.





**cinerea var.
longistaminea**

Copiapoa cinerea var. *longistaminea* (Ritter) Slaba, Kaktusy XXXIII Special p3 (1998). Basionym: *C. longistaminea* Ritter in Taxon 12: 31 (1963)

This beautiful clumping variety of *C. cinerea* occurs near the sea at Esmeralda. It was originally described by Ritter in 1963, but remains rare in cultivation. The individual heads, many of which have the most wonderful white epidermis, are up to 15cm diameter, and they form neat mounds of heads up to a little over a metre in diameter. The spines are brownish at first, later becoming black.

This variety grows in the company of four other *Copiapoa* species: *C. cinerascens* and its variety *grandiflora*, *C. cinerea* var. *columna-alba*, *C. humilis* var. *esmeraldana*, and *C. hypogaea* var. *laui*. I believe it is worthy of varietal status because of its geographic separation from the type, and its different habit. There is a gap between the distribution of this variety, north of Esmeralda, and the type at Taltal. The only variety in that region is var. *columna-alba*. There is a reference to a *C. cinerea*-like plant growing just south of Cifuncho, which is illustrated by Schulz and Kapitany (1996) as picture 124, and is probably the same as that pictured by Meregalli and Doni (1991) in their Plate 15 (mis-identified by them as *C. serpentisulcata*). Rather than a form of the type, this appears to be a heavily spined form of *C. cinerea* var. *columna-alba*, which is known to occur even further north and which I have seen in the coastal hills between Cifuncho and Taltal.

Although *C. cinerea* var. *longistaminea* grows in the immediate company of *C. cinerea* var. *columna-alba*, I have seen no record of hybrids. When I saw

Fig.45
Copiapoa cinerea
var. *longistaminea* in
habitat at Esmeralda,
GC 128.01





it in habitat in November 1994 there were no flowers or fruits, which I understand is often the case and might explain why seed is so difficult to obtain. There have been various importations of this plant into Europe including many plants from Lau. Karel Knize sent this species under the incorrect name of *C. esmeraldana*, which grows in the same area but is a variety of *C. humilis*.

None of my friends who have visited the habitats have ever found seeds on plants in the wild, although flower remains are often in evidence. I have never seen authentic seedlings in cultivation — presumably a direct result of the lack of imported seed. None of my imported plants has ever flowered.

Top Fig.46

Copiapoa cinerea var. *longistaminea* in habitat at Quebrada Guanillos

Bottom Fig.47

Copiapoa cinerea var. *longistaminea* in cultivation, ex habitat, RMF 160



Copiapoa coquimbana

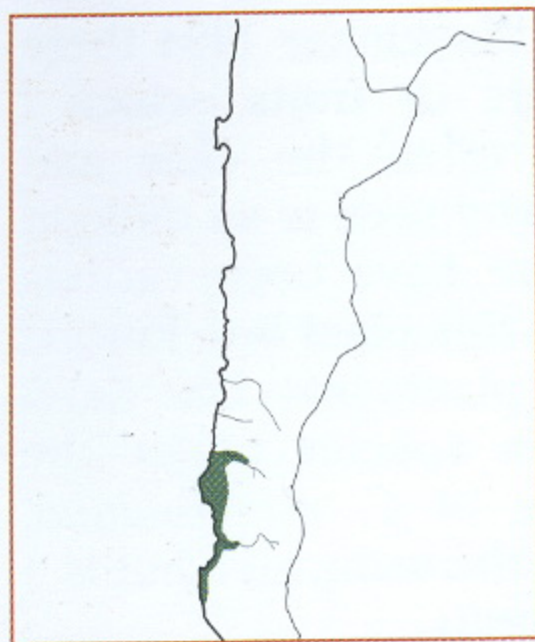
Copiapoa coquimbana (Karw. ex Rümpler) Br. & R., The Cact. III:87 (1922). Basionym: *Echinocactus coquimbanus* Karw. ex Rümpler (1885)

Synonyms: *Copiapoa wagenknechtii* Ritter (1959); *C. pendulina* Ritter (1959); *C. coquimbana* var. *wagenknechtii* Ritter (1963); *C. pseudo-coquimbana* Ritter (1963); *C. pseudocoquimbana* var. *vulgata* Ritter (1963); *C. alticostata* Ritter (1963); *C. vallenarensis* Ritter (1980); *C. coquimbana* var. *armata* Ritter (1980); *C. coquimbana* var. *chaniar-ensis* Ritter (1980); *C. coquimbana* var. *pseudocoquimbana* (Ritter) Hoffmann (1989); *C. coquimbana* var. *vallenarensis* (Ritter) Hoffmann (1989); *C. coquimbana* var. *pendulina* (Ritter) Hoffmann (1989); *C. coquimbana* var. *alticostata* (Ritter) Hoffmann (1989)

Taylor (1981) did not choose to use the name *C. coquimbana* for this, the most southerly species of *Copiapoa*, which occurs on the fringe of the winter rainfall area, but preferred instead to use the later Ritter name of *C. wagenknechtii* since he felt the application of *Echinocactus coquimbanus* was not clear. *Echinocactus coquimbanus* was described by Karwinsky in 1885 from a plant in cultivation, believed to have been collected near the town of Coquimbo, just south of La Serena, on the Chilean coast. The brief description which constitutes the type is a reasonable match for the only *Copiapoa* found in that area today. I propose, therefore, to accept this as the oldest name for this variable species, which was also the conclusion

of Britton and Rose in 1922 and Hoffmann in 1989. (Fig. 5.)

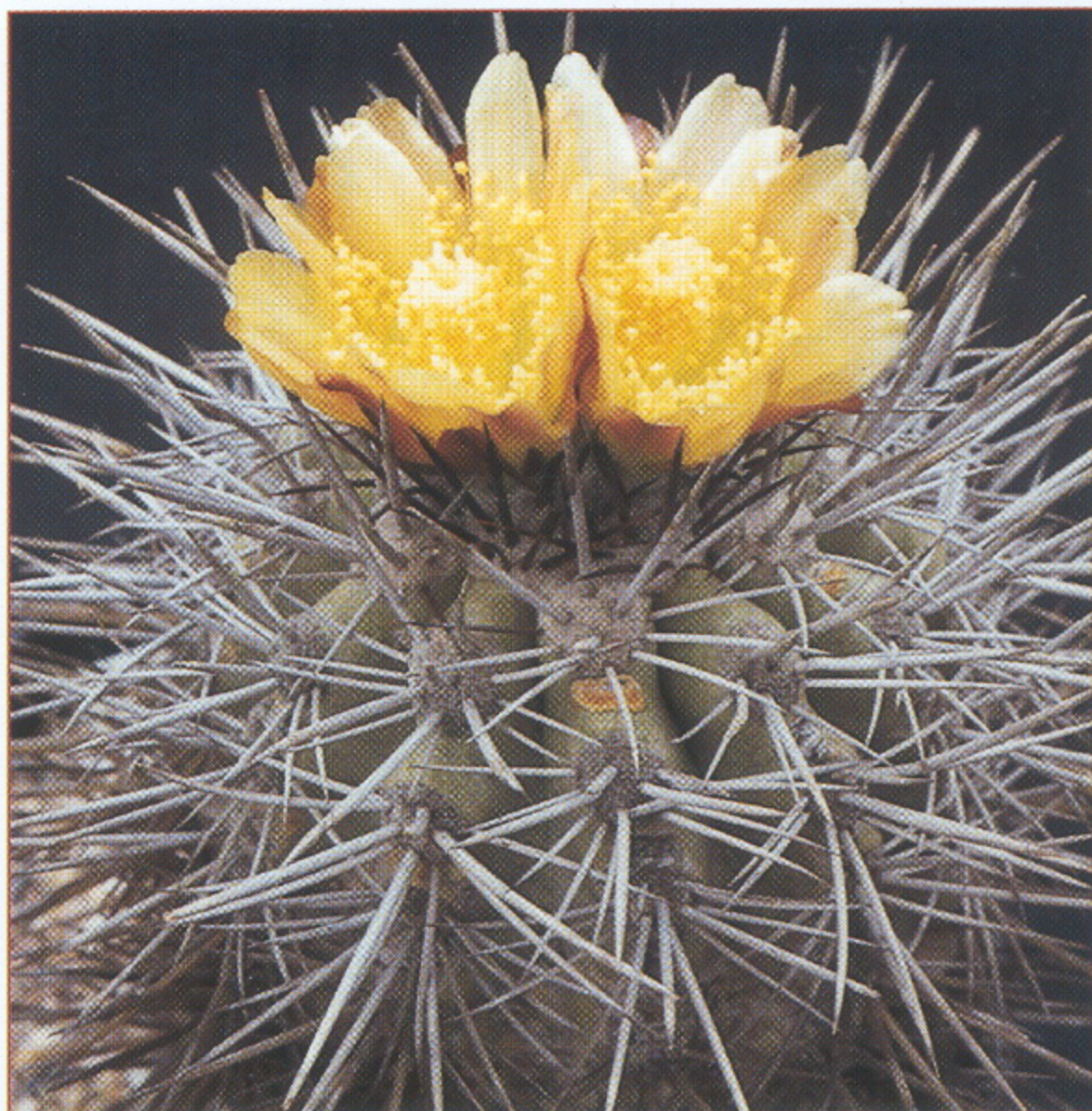
The variability of the species has resulted in many names being erected for local populations from Huasco in the north, to south of Fray Jorge. At its most southerly occurrence, this species develops elongated bodies which can be found hanging down the coastal cliffs. This form was described by Ritter in 1959 as *C. pendulina*. It is tempting to consider all of these as forms of one species, but I feel that the most northerly population, which grows north of the valley of the Rio Huasco, is distinct enough to retain the varietal status, *C. coquimbana* var. *fiedleriana*, accorded to it by Hoffmann.



coquimbana
var. coquimbana

Fig.48
Copiapoa coquimbana
(*alticostata*) in habitat
at Maitencillo,
RMF 275





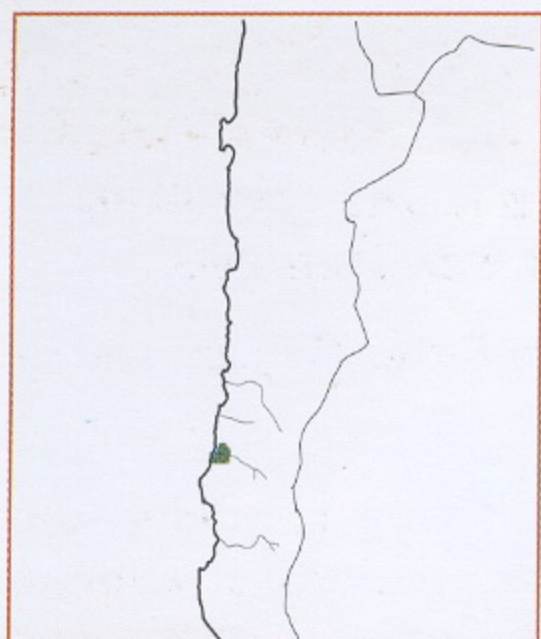
Top left Fig.49 *Copiapoa coquimbana* (*pseudocoquimbana*) in cultivation, ex habitat, RMF 77

Right Fig.50 *Copiapoa coquimbana* (*pendulina*) in cultivation, raised from commercial seed



C. coquimbana is a very common plant along the coast and into the Elqui and Huasco valleys, as well as some inland localities between. It often forms large clumps which, next to the tall eulychnias, can be the most prominent plants in the area. When I saw them, many populations were suffering from drought stress, while others, like the ones in the lower Elqui valley, were glowing with health and exhibiting a slight white bloom which is more usually associated with the species from further north. It occurred to me that this species enjoys a generally moister climate than its northern relatives and as a result flowers regularly and produces more seed, probably every year.

Fig.51 *Copiapoa coquimbana* (*wagenknechtii*) in habitat at the Elqui Valley, GC 91.01



**coquimbana
var. fiedleriana**

Copiapoa coquimbana var. *fiedleriana* (Schumann) Hoffmann, Cact. Fl. Chil.: 108 (1989). Basionym: *Echinocactus fiedlerianus* Schumann (1903)

Synonyms: *Copiapoa fiedleriana* (Schumann) Backbg. (1935); *C. pepini-ana* var. *fiedleriana* Backbg. (1959)

First described by Schumann as *Echinocactus fiedlerianus* in 1903, this plant was included in *Copiapoa* by Backeberg in 1935 and then reduced to a variety of *C. coquimbana* by Hoffmann in 1989. This variety can be found at the northern end of the distribution of the species; it is common on the dry hills overlooking the lower reaches of the Huasco valley, where it forms clumps of dark-bodied, spherical heads. It is intermediate between *C. coquimbana* and *C. megarhiza* var. *echinata*, which occurs further north. A characteristic of this variety is a prominent protuberance below the areole, more pronounced than I have seen in any other species of *Copiapoa*. This is possibly the same plant as *Echinocactus cupreatus* Poselger ex Hildmann (1885), which was based on a cultivated plant of

unknown origin, but interestingly the description made reference to protuberances, so this, together with body colour, suggests that it might have been this plant.

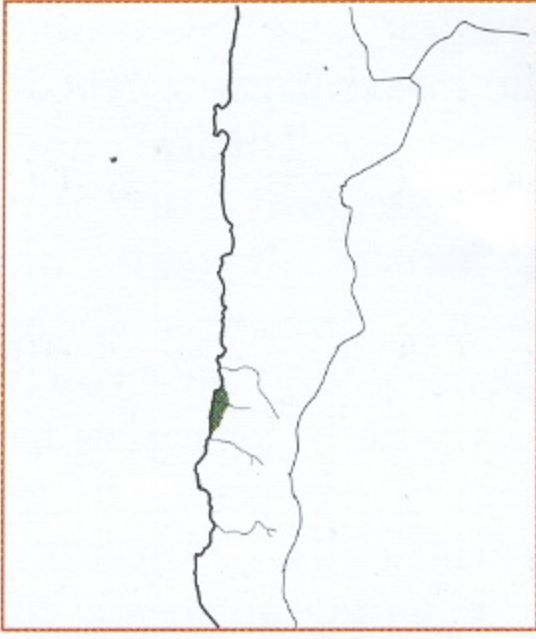
In cultivation, in its many forms, *C. coquimbana* is the commonest of the larger-growing species. Unless care is taken with water and feed and it is given a sufficiently sunny locality, it has a tendency to grow columnar, quite atypically. Most forms will flower well in glass-houses in northern Europe, quickly forming clumps, but they make less spectacular specimens than the slower growing species from the north.



Fig.52
Copiapoa coquimbana
var. *fiedleriana* in
cultivation, raised from
habitat seed, KZ 21



Fig.53
Copiapoa coquimbana
var. *fiedleriana* in
habitat 5km east of
Huasco, GC 109.01



Copiapoa echinoides

Copiapoa echinoides (Lemaire ex Salm-Dyck) Br. & R. The Cact. III:88 (1922). Basionym: *Echinocactus echinoides* Lemaire ex Salm-Dyck

Synonyms: *Copiapoa cuprea* Ritter (1959); *C. dura* Ritter (1963); *C. echinoides* var. *cuprea* (Ritter) Hoffmann (1989)

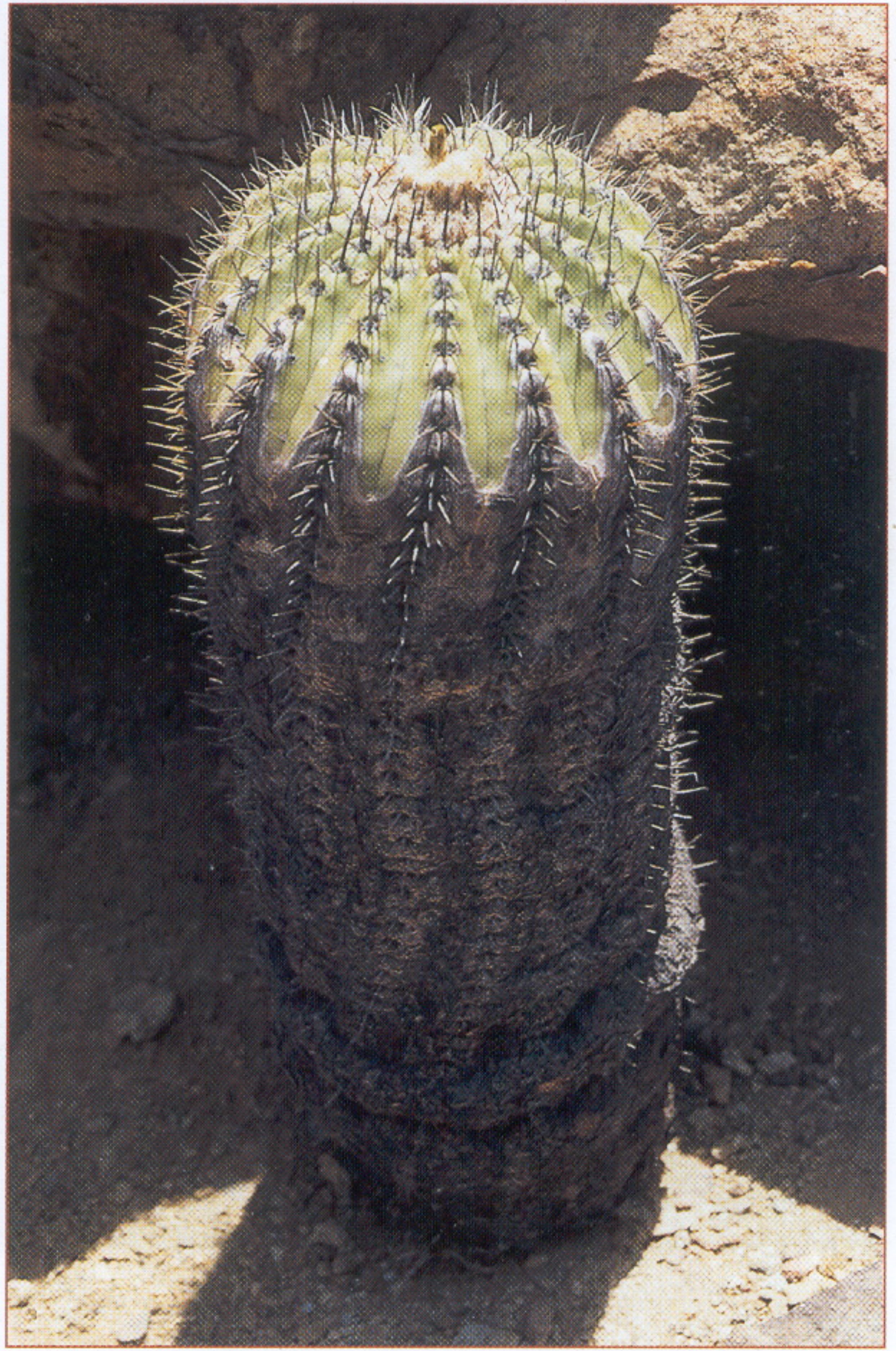
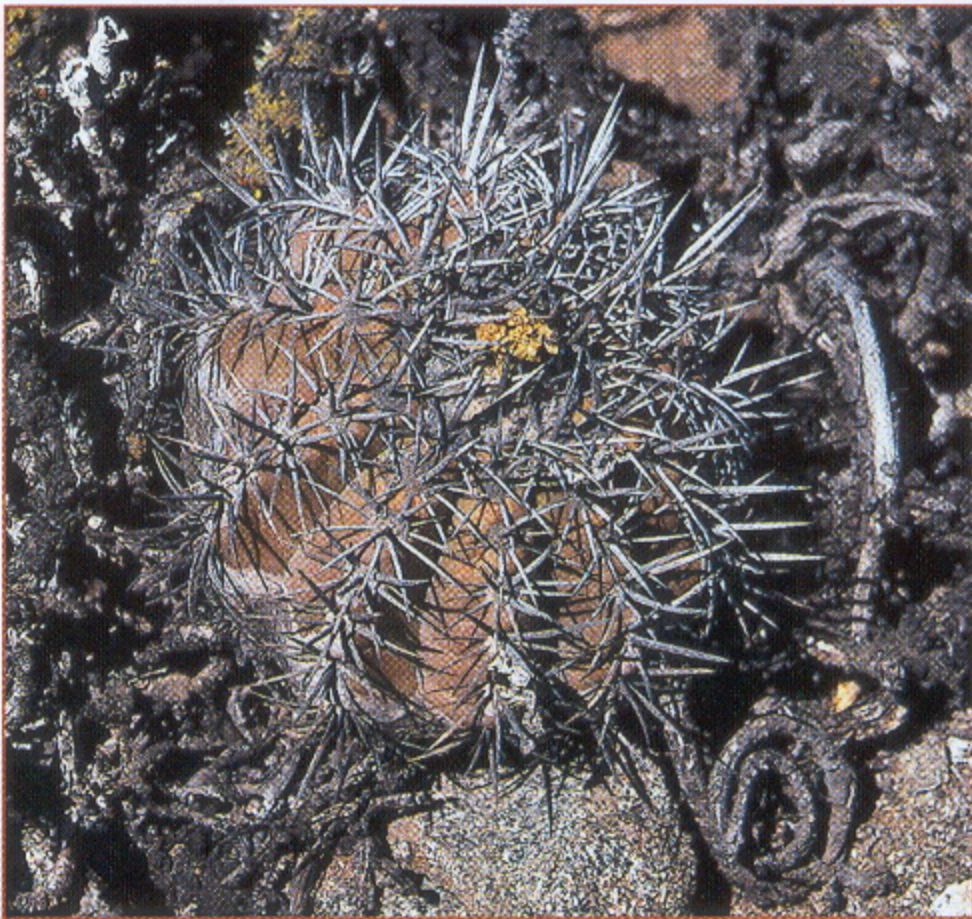
One of the species found during the explorations of Thomas Bridges and described subsequently by Salm-Dyck. The excellent illustration of Pfeiffer (1850) (Fig.2), which is reproduced in Britton and Rose, has a closer resemblance to the plant which Ritter later described as *C. dura* than to any other species. This plant occurs near to Totoral, a place visited by Bridges so it would appear that *C. echinoides* is the earliest name for this.

Top left Fig.54
C. echinoides (*cuprea*)
in habitat 27km N of
Carrizal Bajo, GC 117.02

Bottom left Fig.55
C. echinoides in
habitat 16km north of
Huasco Bajo, GC 111.01

Right Fig.56
C. echinoides in habitat
near Totoral, RMF

The description of this species as re-published in Britton and Rose reads: "Simple, globose, very woolly at apex; ribs 8 to 13, straight, rounded, green; flowers pale yellow; outer perianth-segments narrowly ovate, acute, reddish; inner perianth-segments broadly oblong, obtuse." This can be amplified considerably by referring to Ritter's description of *C. dura* (*Taxon* 1963) and indeed *C. cuprea* (*Cactus* 1959), both of which are more recently published names for this species.





This species can be found along the coast from north of Huasco up to Totoral and inland some way up the Totoral valley. It can be solitary or clustering, some populations having the brown epidermis which gave rise to the name *C. cuprea*. It is characteristically broader than it is wide, although in some places it will grow taller, particularly when older. Roger Ferryman reports finding columnar specimens up to one metre tall (Fig.56) growing in sheltered locations (Chileans No. 45).

Fig.57
Copiapoa echinoides
(*cuprea*) in cultivation,
ex habitat

The seedlings are tuberculate when young, taking some time to develop the familiar prominent ribs. Examples with heavy black spines are spectacular plants, and even seedlings in Europe can have strong spination and a deep brown body after a few years.

C. marginata may be a more northerly relative of this species, but Roger Ferryman reports a distinct gap between the two north of Totoral, in an area of sand dunes where only *C. megarhiza* var. *echinata* grows.



Fig.58 *Copiapoa echinoides* in cultivation, ex habitat, RMF 295



humilis
var. humilis

Copiapoa humilis

Copiapoa humilis (Philippi) Hutchison Cact.Succ.J. (US) 25:34-7 (1953)
Basionym: *Echinocactus humilis* Philippi (1860)

Synonyms: *Copiapoa paposoensis* Ritter (1980); *C. humilis* var. *paposoensis* (Ritter) Hoffmann (1989)

The first description of this widespread and variable species was in 1860 by the German botanist R.A. Philippi, who was the director of the National Museum in Santiago at the time. This description was not sufficient to allow Britton and Rose to place the plant in their new genus *Copiapoa* with any certainty, since a type specimen could not be traced in the Philippi Herbarium in Santiago. It was not until 1953 that the combination was made by Hutchison in the US Journal.

Hutchison expanded the description as follows: "Plant with a tuberous root 15cm or more long and ca. 5cm diam., root apex rounded or flattened. Mature plant solitary or caespitose, stem subglobose, glaucous green, usually connected to root apex by a narrowly constricted stem elongation 5 to 10mm diam. and $\pm$ 4cm long. Stem 5 to 7cm diam., 4 to 6cm high, ribs obscure, 8 to 12, tuberculate. Areoles grey-felted, spines grey, straight or slightly curved, radial spines 10 to 14, 5 to 15mm long, spreading to suberect, central spines 1 to 4, erect, porrect or barely decurved, 1.0 to 2.5cm long, darker apically. Flowers apical, lower third submerged in dense, grey, apical wool, campanulate, 3cm (2cm in type!) long, outer perianth segments yellow with a rose midstripe which on lower segments is broader, lowest segments rose narrowly margined yellow, inner segments dark yellow. Filaments, anthers and style dark yellow, stigma orange yellow. Style 2.0cm long, lobes 9, 3mm long, minutely papillose, slightly exerted. Fruit semiglobose, truncate, 9mm diam., 8mm tall, with a single subapical ovate-acute scale 2mm broad and 3mm long, bright red."

Fig.59
Copiapoa humilis
in habitat at Paposo,
GC132.02



Hutchison makes a point about 90 per cent of the stems being immature, stating that the mature stems differ greatly. He goes on to say that the original description combined characters of both. The reason for the high percentage of immature stems is, according to Hutchison, the insect depredation which seems to affect only the mature stems. This, combined with a natural process of new stems growing from old tuberous roots after previous stems have died, results in many immature stems, which he says rarely appear to reach maturity, resulting in little propagation by seed. Schulz and Kapitany (1996) describe the damage done to the plants by guanacos (larger and more elegant relatives of the llama), which can also lead to the



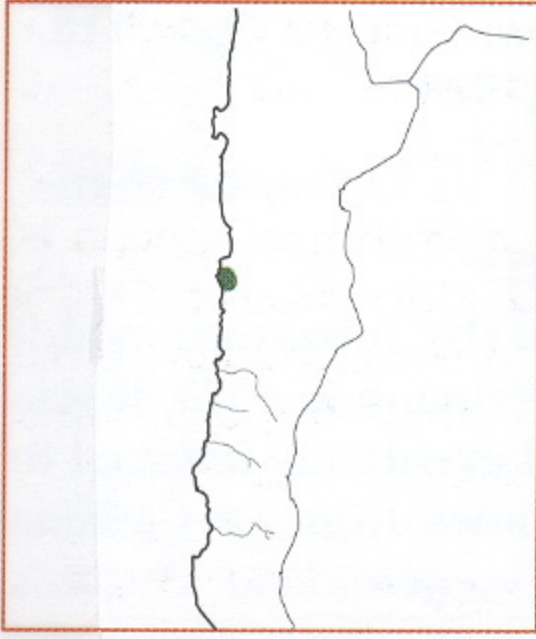
Fig.60
Copiapoa humilis
in cultivation,
ex habitat, TJ 55

Fig.61
Copiapoa humilis
in cultivation,
ex habitat Paposo

C. humilis is one of the smaller species of *Copiapoa*, one of the so-called soft bodied ones, and is probably the commonest species in cultivation since it is very easy to grow and flower. Most plants I have seen are not of the form shown by Hutchison (Fig. 61), from the hills above Paposo, which usually has pinkish stems, but are more similar to the varieties *longispina* or *taltalensis*, which are larger, greener bodied, with longer spines (Fig. 60). I understand that at lower altitude, near Paposo, there are plants with more elongated bodies and a lax habit; plants with the field collection number PM 200 (from seed collected near Paposo by Ken Preston-Mafham) are of this form.



There are a number of varieties of *C. humilis* which were originally described as species in their own right, but are best considered as varieties of one variable species whose range can then be seen to extend from Copiapo in the south to Tocopilla in the north. Since *C. humilis* tends to be found in the coastal mountains rather than where the roads are, it is likely that there are more, currently unknown locations for it, between the populations which are more accessible and have been named.



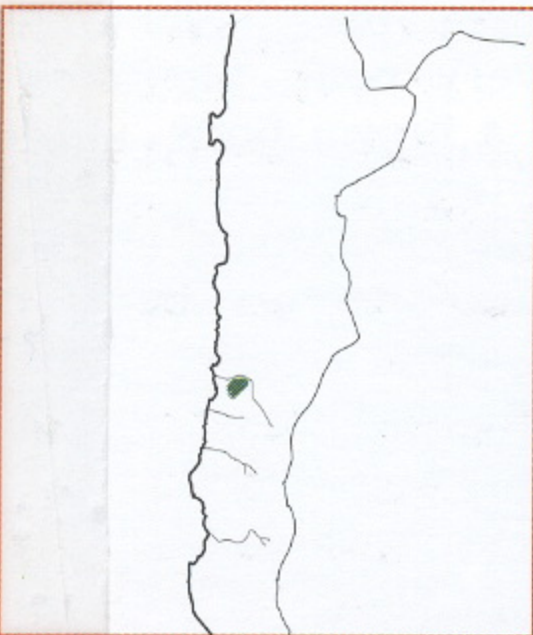
**humilis var.
esmeraldana**

Copiapoa humilis var. *esmeraldana* (Ritter) Hoffmann, Cact. Fl. Chil.: 118 (1989). Basionym: *Copiapoa esmeraldana* Ritter (1980)

Ritter states that this comes from south of Esmeralda, but we found plants which I believe are this variety, growing in the Guanillos Valley just north of Esmeralda, along with *C. hypogaea* var. *laui* and *C. cinerascens* var. *grandiflora*. This population is described and illustrated by Schulz and Kapitany (1996), but the Ritter locality must be a different valley, otherwise one assumes he would surely have seen *C. hypogaea* var. *laui* and described it. Apparently Hutchison also visited this area but failed to find *C. hypogaea* var. *laui*.

Fig.63 *Copiapoa humilis* var. *esmeraldana* in habitat at Esmeralda, GC 129.01

Fig.62 *C. humilis* var. *esmeraldana* in cultivation, ex habitat, RMF 161



**humilis
var. longispina**

Copiapoa humilis var. *longispina* (Ritter) Hoffmann, Cact. Fl. Chil.: 118 (1989). Basionym: *Copiapoa longispina* Ritter (1963)

This is the most southerly described variety of *C. humilis*, from the Sierra Hornillos, south of Copiapo (stated incorrectly by Hoffmann to come from north of Paposo [1989]). Many plants are in cultivation with this name, but

I cannot recall seeing any with a provenance linked to the type locality. All that I have seen look much like *C. humilis* var. *taltalensis* from further north, with larger green bodies, longer spines and a larger growing habit than the type, eventually forming big clumps in cultivation. The illustration shows an original Ritter-collected plant, in cultivation, photographed by Roger Ferryman. He has also seen plants in habitat at Ritter's locality, confirming this very southerly occurrence of *C. humilis*.



Fig.64
Copiapoa humilis var. *longispina* in cultivation, ex habitat, FR 505



humilis
var. taltalensis

Copiapoa humilis var. *taltalensis* (Werd.) Hoffmann, Cact. Fl. Chil.: 118 (1989). Basionym: *Echinocactus taltalensis* Werd. (1929)

Synonyms: *Copiapoa taltalensis* (Werd.) Looser (1929); *Copiapoa chan-iaralensis* Ritter (1980)

This was the first variety of *C. humilis* to be found (by Johnston), and it was described as *Echinocactus taltalensis* by Werdermann in 1929. It was soon transferred to *Copiapoa* by Looser (1929) and eventually reduced to a variety of *C. humilis* by Hoffmann (1989). It comes from La Cachina which is very near to the locality of *C. humilis* var. *esmeraldana*, and this makes me wonder if the two can really be different. Illustrations and descriptions of this variety show only small differences from var. *esmeraldana*. I have included Ritter's *C. chaniaralensis* from near Chañaral within the scope of this variety.



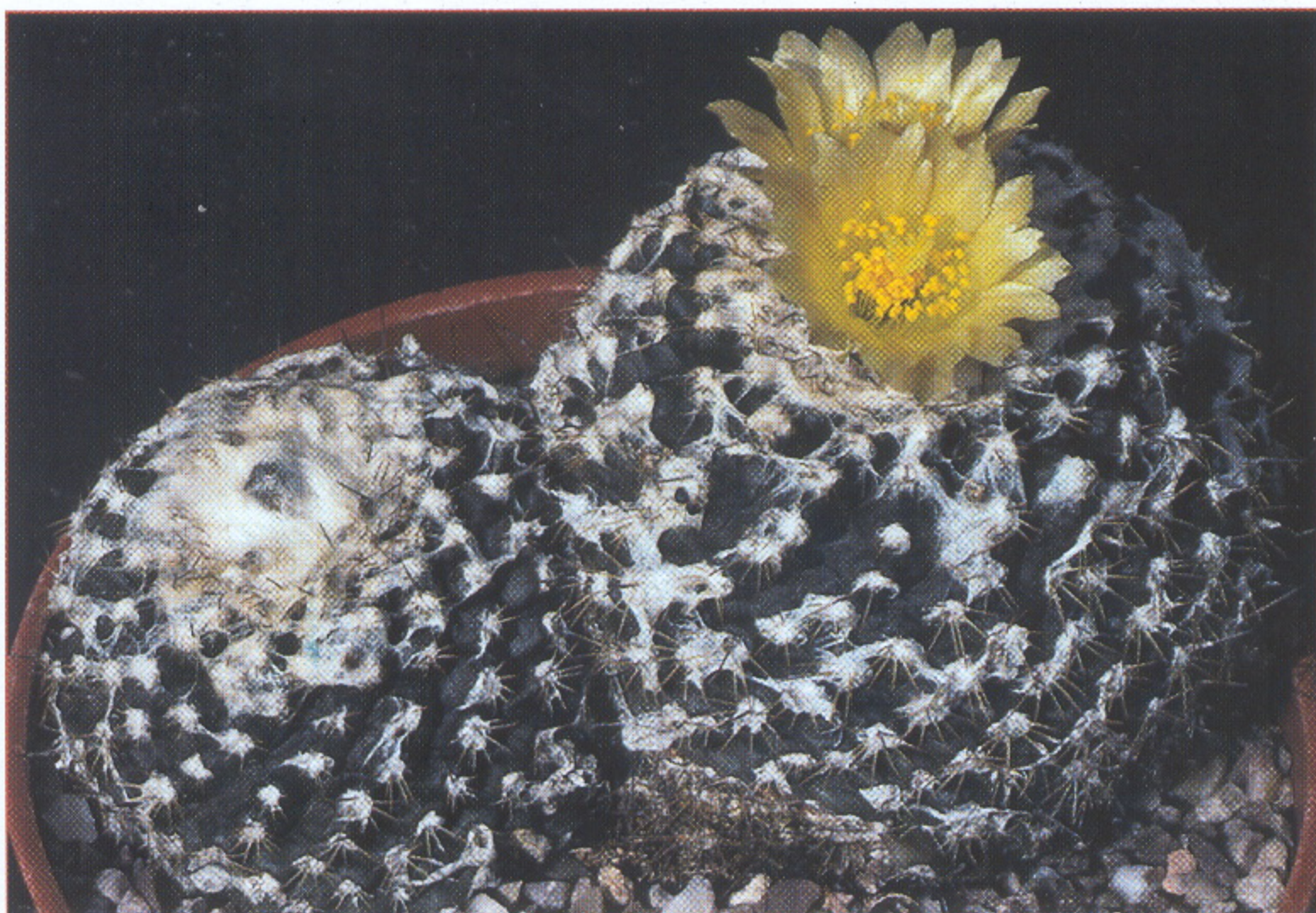
humilis
var. tenuissima

Copiapoa humilis var. *tenuissima* (Ritter) G. Charles, BCSJ 16:15 (1998). Basionym: *C. tenuissima* Ritter, Taxon 12 (1): 31 (1963)

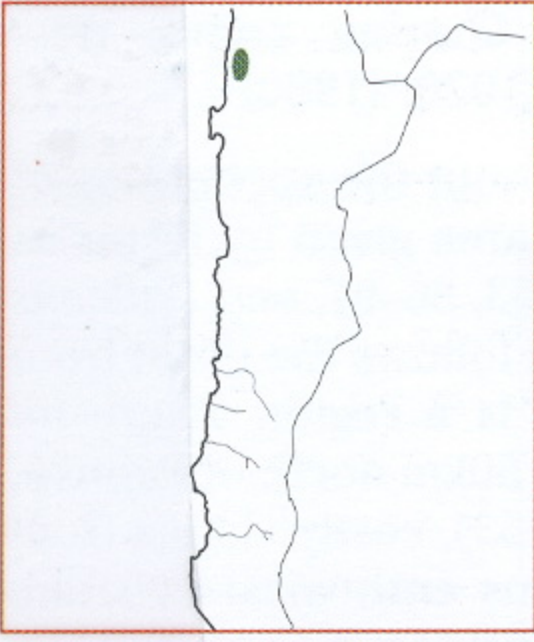
Before the discovery of the plant originally described as *C. laui* (now *C. hypogaea* var. *laui*), this was regarded as the smallest *Copiapoa*. It is popular in collections and is easy to cultivate.



This plant is difficult to find in its habitat, south of Antofagasta, where it grows in the coastal mountains. Plants very like it have been reported as far south as Miguel Diaz by Roger Ferryman (pers. comm.). It has very neat, fine spination, a brown body and a large, tuberous root. It is popular because of its unique appearance and ease of flowering. Although it will flower when only a few years old, it is very slow growing — the illustrated plant is 30 years old and is growing in a 13cm pot. Taylor (1981) suggests that var. *tenuissima* could have arisen as a fixed juvenile (neotenus) form of *C. humilis*.



Top Fig.65
Copiapoa humilis
var. *tenuissima* in habitat
east of El Cobre
Bottom Fig.66
Copiapoa humilis var.
tenuissima in cultivation,
30 years old, raised from
commercial seed



**humilis
var. tocopillana**

Copiapoa humilis var. *tocopillana* (Ritter) G. Charles, BCSJ 16:15 (1998)
Basionym: *C. tocopillana* Ritter, Kakt. Südamer. 3: 1072 (1980)

This is the most northerly *Copiapoa* known to exist today, and its survival is seriously threatened by the increasing aridity of the region (as discussed on page 8). It is very rare in cultivation because it has been found in the wild by few people, and many plants distributed commercially under the name *C. tocopillana* are not this at all, but often are *C. atacamensis*, another of the hard-bodied species.

I have never seen authentic seedlings of this species in cultivation, and I am not aware of any 'breeding population' of habitat collected specimens in cultivation able to supply seed to make this plant more common.



Right Fig.67
Copiapoa humilis var.
tocopillana in habitat
at Tocopilla, RMF 312

Bottom left Fig.68
Copiapoa humilis
var. *tocopillana* in
cultivation, ex habitat,
RMF 312

Bottom right Fig.69
Copiapoa humilis
var. *tocopillana*
in cultivation
(approx. 8cm tall),
ex habitat





**humilis
var. varispinata**

Copiapoa humilis var. *varispinata* (Ritter) G. Charles, comb. nov.
Basionym: *C. variispinata* Ritter, Kakt. Südamer. 3:1070, (1980)

There has been considerable discussion recently about the application of this name to plants growing near Miguel Diaz, the area given by Ritter as the place he found the plant in 1968 (see *Chileans* 53, 86–91, and *Chileans* 55, 10–11). Travelling north on the only road, which follows the coast from Paposo, after the last forms of *C. cinerea*, there is a region where no copiapos can be found. Then, near to Miguel Diaz, 50km north of Paposo, there grows a prominent clumping *Copiapoa* (RMF 53), easily visible from the road, which has been reported by many cactus enthusiasts visiting the area (Figs. 6 & 7). This has generally been considered to be Ritter's *C. varispinata* (originally published as *variispinata*, but the spelling was corrected in the *IOS Index of Names of Cactaceae* to a single 'i'), but the problem is that it does not fit the original description, as pointed out by Roger Ferryman in the *Chileans*' articles. Roger goes on to say that he has found a plant in the higher reaches of this area which is close to *C. humilis* (Fig.70) and matches the description of *C. varispinata*; he has obtained a propagation from FR 1447 (the type collection) and confirms that this is a form of *C. humilis*. I have seen this cutting, and a photograph of the plant from which it was taken, and concur with Roger. This is all in keeping with what Ritter says in placing his *C. varispinata* close to *C. humilis*, and hence I am inclined to go along with this observation as being the most likely correct application of the name.

The only unsatisfactory consequence of this decision is that it leaves the prominent coastal species (RMF 53) without a name, which is odd, bearing in mind the likelihood that Ritter must have seen it. Perhaps Ritter did intend the name *varispinata* to apply to this plant, but got his notes mixed up before he described it. We shall probably never know, and I believe that this clumping plant should be described properly; it has no obvious relatives and could be a new species. Interestingly, Philippi visited Miguel Diaz in 1853 and reported seeing an *Echinocactus* where the quebrada met

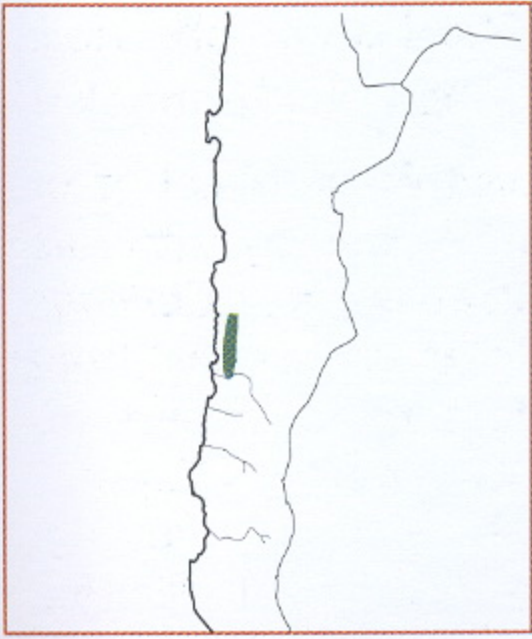
the coast — perhaps this was the clumping *Copiapoa* species that we now find near to the road, or possibly a species of *Neoporteria*.

Furthermore, there is another species in the nearby Botija Valley which has a resemblance to *C. cinerea* and which also does not have a name (Fig. 8). This was reported by Roger Ferryman and Alan Craig, and subsequently pictured in the book by Schulz and Kapitany (pp. 137–141). Perhaps this is the most northerly form of *C. cinerea* and could be worthy of varietal status.

(See page 6 for further details of the two undescribed plants.)



Fig.70
Copiapoa humilis var. *varispinata*
in habitat at Caleta Botija, RMF



Copiapoa hypogaea

Copiapoa hypogaea Ritter, Cactus (Paris) 15(66):19-20 (1960)

Synonyms: *Copiapoa hypogaea* var. *barquitensis* Ritter (1980); *C. mollicula* Ritter (1963)

This popular dwarf species from the coastal hills near to Chañaral was first described by Ritter in 1960. He later described *C. hypogaea* var. *barquitensis*, a form from Barquito, just to the south, which is now considered to be a synonym. Also included here is *C. mollicula* (Ritter) from north of Chañaral, which although easily distinguished from *C. hypogaea* in cultivation, is just a northerly form.

A selected part of the type description for *C. hypogaea* from Ritter, in translation, reads: "Body: single or double-headed, soft bodied, in habitat

flush with the ground or even sunken into the ground; the assimilatory part of the plant itself is flat or sunken towards the middle, forming a small, shallow hollow. Tuberos root with a narrowed stem; heads 30–65mm thick, grey-brown, very occasionally green, almost the same colour as the desert earth in which the species grows; crown with white down. Ribs: 10–14, often a little twisted, in habitat running out into broad, flat humps of about 4–7mm diameter and similar height, somewhat chin-like in lower parts; whenever ribbing is recognisable, dividing furrows are not, or only very slightly wavy. A characteristic is the presence of small, fine grooves on the plant's surface, running down from the areole to the base of the tubercle; the grooves look like some form of wrinkling, but they are also present when the cactus is full of sap, at least this is what I found in plants taken from where I found them and which I had kept moist. Areoles: 1.5–3mm long, somewhat thinner, 4–10mm



Fig.71
Copiapoa hypogaea
in habitat 3km north
of Chañaral



Fig.72
Copiapoa hypogaea
in cultivation, raised
from commercial seed



Top left Fig.73
Copiapoa hypogaea
(*mollicula*) in
cultivation, ex habitat,
RMF 132



Top right Fig.74
Copiapoa hypogaea
(*mollicula*) in habitat
above Agua Leones

apart, sunk into the upper part of the tubercle, downy-white. Spines: missing from most plants; others have 1–6 black radial spines, which do not turn grey, from 2–4mm, no central spines. If spines are more profuse then this is usually a hybrid, which may also be found in habitat.”

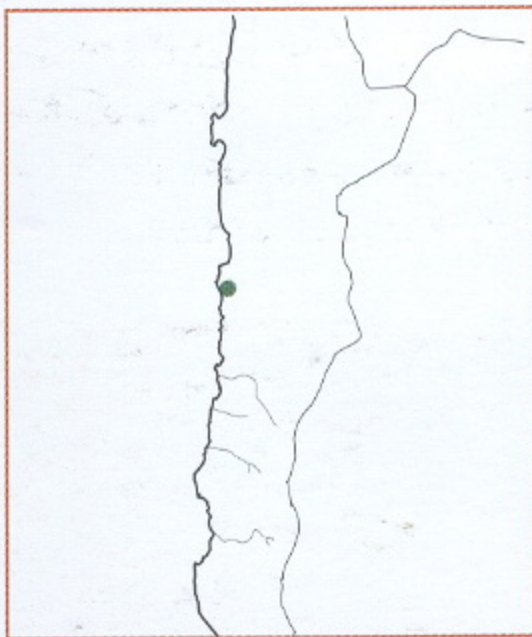
This is a very good species for the collector. It grows quite slowly and flowers when small. The body is a beautiful brown colour, with black spines and a crown full of wool. There is a strain available in cultivation with an interesting, rough, dark brown epidermis, which comes true from seed, but I do not know if it occurs in nature. I have retained *C. hypogaea* as a separate species from *C. humilis* although clearly they are similar; someone looking to reduce the number of *Copiapoa* species still further could combine them.

Copiapoa hypogaea var. *laui* (Diers) Hoffmann, Cact. Fl. Chil.: 120 (1989).
Basionym: *Copiapoa laui* Diers (1980)

This remarkable plant remained undiscovered for years, presumably because of its diminutive size. When Lau found it, he thought he had found a *Thelocephala* (a small, tuberous rooted *Neoporteria*). It was not until he saw the flowers and characteristic fruits that he realised that he had found the smallest known *Copiapoa*. It was described as *C. laui* by

Diers in *KuaS* 31(12): 362-5 (1980) and then, in 1989, reduced to a variety of *C. hypogaea* by Hoffmann.

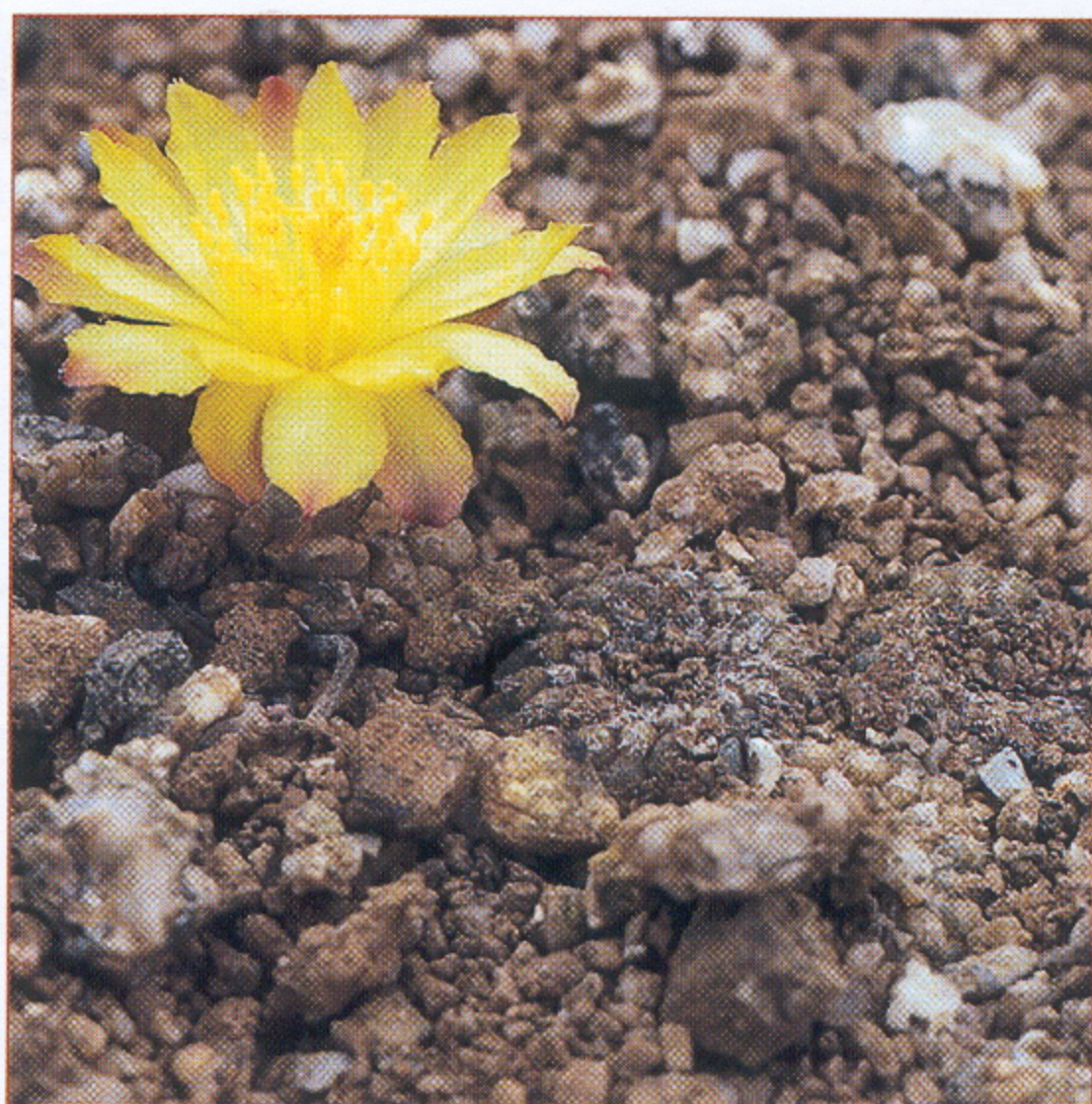
This is an outstanding plant to cultivate, making clusters of small heads, each only up to 20mm diameter and with a well developed taproot. The flowers are freely produced throughout the summer, often in great profusion. I have observed in seed raised plants some variation in body form, with some clones remain-



hypogaea
var. *laui*



Fig.75
Copiapoa hypogaea
var. *laui* (large form)
in cultivation, ex
habitat, RMF 324



Top left Fig.76
Copiapoa hypogaea
var. *laui* in habitat at
Esmeralda, GC 129.03

Top right Fig.77
Copiapoa hypogaea
var. *laui* (large form) in
habitat at Pan de
Azucar, RMF 324

ing quite flat while others tend to develop elongated bodies. The clusters are never as flat to the ground as those in the wild, but good light and careful feeding and watering should result in a good clump. Propagation can also be achieved by rooting the heads, which are slow at first while they make tap roots and then grow quite quickly; the woolly offsets sometimes start to develop during one growing season, and grow to full size during the next.

We found large mats of this plant in the Guanillos Valley near to Esmeralda, growing with *C. cinerascens* var. *grandiflora* and *C. humilis* var. *esmeraldana*. It was difficult to walk without stepping on the heads. It grew in fairly flat, gravelly areas near the tops of low hills; the heads were densely packed, making it impossible to decide how many clusters there actually were. Roger Ferryman found a larger headed form of this variety, which had less of the white wool, growing in the hills further south.



Fig.78
Copiapoa hypogaea
var. *laui* in cultivation,
ex habitat, RMF 162



**hypogaea
var. montana**

Copiapoa hypogaea var. *montana* (Ritter) G. Charles, BCSJ 16:15 (1998).
Basionym: *C. montana* Ritter in Cactus (Paris) 15(66): 21-22 (1960)

Synonyms: *C. olivana* Ritter (1980); *C. rarissima* Ritter (1980)

C. montana is the oldest name for the relatives of *C. hypogaea* which can be found in the coastal hills near to Taltal. I include three of Ritter's species under this variety name; they are *C. montana* (1963), *C. olivana* (1980) and *C. rarissima* (1980). Although some of the plants in cultivation under the name *C. olivana* appear to have affinities with *C. humilis*, plants I have seen collected by Roger Ferryman are closer to *C. hypogaea*.

From Ritter's description, it appears that his *C. rarissima* might be an aberrant form, which he subsequently believed may have become extinct through being eaten by animals. He found only a few plants of which just one was sent to Europe, so we are not likely to see authentic material in cultivation. Ritter reported it as being sterile, and he produced seed only

by crossing it with *C. olivana*. It was growing in an area of white shingle, 3km south of Paposo. I am unaware of any field collectors who claim to have refound *C. rarissima*. Indeed, the location given above was taken from Ritter's handwritten field notes and, I believe, was never published. I place it here because of the similarity of its description with *C. hypogaea* and Ritter's statement that it is not close to *C. humilis*.



Fig.79
Copiapoa hypogaea
var. *montana* in
habitat north of
Quebrada San Ramon



Fig.80
Copiapoa hypogaea
var. *montana* (*olivana*)
in cultivation, ex
habitat, TJ 60



marginata
var. marginata

Copiapoa marginata

Copiapoa marginata (Salm-Dyck) Br. & R., The Cact. III:86 (1922).
Basionym: *Echinocactus marginatus* Salm-Dyck (1845)

Synonyms: *Echinocactus columnaris* Pfeiffer (1847); *Echinocactus streptocaulon* Hooker (1851); *Copiapoa streptocaulon* (Hooker) v.Oosten (1940)

One of the earliest species to be described, and cited by Britton and Rose as the type species of their new genus *Copiapoa* when they erected it in 1922. The first description of this species was by Salm-Dyck (1845) as *Echinocactus marginatus*, from plants collected by Thomas Bridges, probably in 1841; but much confusion ensued due to the original description being too vague to facilitate precise attribution to plants more recently found in habitat (See Fig. 4 for an illustration of *Echinocactus streptocaulon*.)

In 1847, Pfeiffer described his *Echinocactus columnaris*, which three years later he made a synonym of *E. marginatus*, illustrating the amplified description with a fine plate (Fig.3). If Pfeiffer was correct in reducing it to a synonym (comparison of the original descriptions does raise some doubts), then we can believe that Ritter found this species again at Morro Copiapo, just to the south of Caldera. The habitat of *C. marginata* had persistently been given as Antofagasta by authors such as Britton and Rose, Backeberg, and Lembcke, but since Bridges is known not to have travelled there, this cannot be accurate. The similar plant which grows there, with which *C. marginata* had been confused, therefore had no name, so the new name *C. atacamensis* was published by Harry Middleditch (*Chileans*, 1980). (See explanation under *C. atacamensis*).

The German part of the original description by Salm-Dyck translates as: "The stem is 6.5in high, 3.5in thick, narrowed towards the top and the base, with domed crown which is furnished with dense white wool. It has

ten ribs, drab ashen-green, which are rounded off towards the top but flattened nearer the base, with very obtuse grooves between. The broad areoles are almost round, flowing together and covered with black felt. The 5-7 radial spines, of which the lowest is the longer and stronger, are more or less standing out in a radiating manner. The single central spine is one inch long and standing straight out; all are stiff and straight, at first chestnut brown, later going ash-grey and under the magnifying

Fig.81
Copiapoa marginata
in habitat at Morro
Copiapo, GC 138.01



Fig.82
Copiapoa marginata
in habitat at Morro
Copiapo, GC 138.01



Fig.83
Copiapoa marginata
in cultivation,
ex habitat, KK



glass are seen to be marked with faint lines. The outer flower petals are upright, lanceolate, pointed and of reddish colour, becoming gradually longer and broader above; the inner flower petals are yellow, broad, blunt with a barely noticeable pointed tip. The crowded filaments as well as the anthers are yellowish; the style is thick and hollow, the 11 stigma lobes yellow."

Plants seen at Morro Copiapo formed clumps with up to about 30 heads. This species is one of the few which naturally grows elongated — although it is not uncommon to see elongated copiaposas in cultivation, this is not generally the normal habitat form of most species. Morro Copiapo is a hill south west of Caldera which is near to being a 'desert island': the west side adjoins sea cliffs and the land side faces a flat plain. This species is recorded only from this isolated locality. It is similar to *C. marginata* var. *bridgesii* (Figs. 84 & 85) which occurs a little further north

C. marginata does not have the white bloom on the body which makes some species so attractive, but in cultivation, when grown in good light, its epidermis takes on a pleasing olive colour. Correctly identified plants are not often seen in collections, due in part to the difficulty in obtaining reliable seed. There are still many plants in cultivation under this name which are in fact *C. atacamensis* and which perpetuate the confusion between the two species.



**marginata
var. bridgesii**

Copiapoa marginata var. *bridgesii* (Pfeiffer) Hoffmann, Cact. Fl. Chil.: 124 (1989). Basionym: *Echinocactus bridgesii* Pfeiffer (1847)

Synonym: *Copiapoa bridgesii* (Pfeiffer) Backbg. (1959)

This was one of the plants first collected by Thomas Bridges and sent to Europe, and subsequently described by Pfeiffer in 1847. Like others described at that time, it is difficult to attribute this name with certainty to any particular plant we know today. Britton and Rose in 1922 agreed with Schumann and referred to it as a synonym of *C. echinoides*. It was Ritter who used the name *C. bridgesii* for a plant he found to the north of Chañaral airfield. When I saw the original illustration in Pfeiffer (Fig.1), my first thought was that it was a form of *C. echinoides*, since the body shape was unlike that of Ritter's plant. However, following Nigel Taylor's reasoning (1981), I have accepted Ritter's attribution of the name since otherwise, as Taylor says, this well-known plant would not have a valid name.

Part of Ritter's description of his neotype, in translation, reads: "Body only clumping a little from the ground, forming a small loose cluster, grass-green, with scarcely developed turnip root; head 5–8cm thick, 20–40cm high, in youth with a flat slightly felted crown, in age conical drawn to a point towards the top, very thick and long grey felted crown. Ribs: young plants about 10–12, only moderately high, later only 8–11 from 10–15mm high, straight, blunt, spreading from the base, very slightly humped. Areoles: young plants small, only a few mm diameter and apart; areoles on older plants 7–10mm diameter, eventually coming together densely in a line. Spines, new, black to brown, soon becoming grey; with young plants radial spines 6–10, short, delicate, half arranged sideways; central spine one projecting straight, rather long. At flowering, radial spines 5–10, awl-like, 1–2cm long; central spines 1–3, very thick, straight, pointed upwards, 15–50mm long, with fibrous surface. Flower: characteristic of *Copiapoa*, scented, 30–38mm long, open funnel shaped."

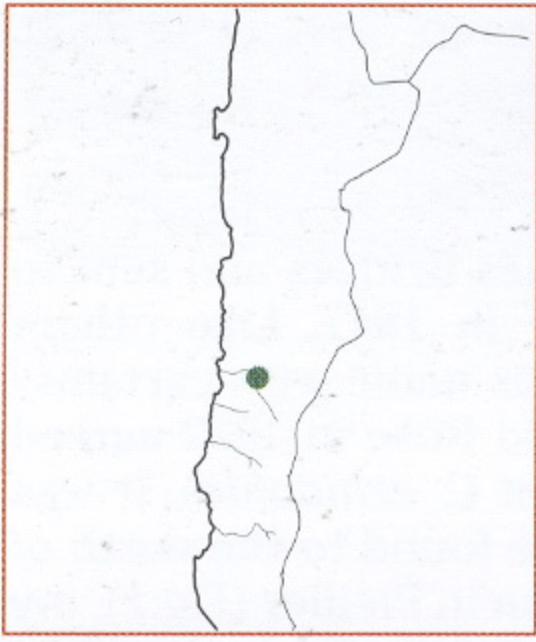
Left Fig.84
Copiapoa marginata
var. *bridgesii* in
cultivation, ex habitat

Right Fig.85
Copiapoa marginata
var. *bridgesii* in habitat
north of Chañaral,
GC123.01



This variety, which is similar to the type, is found on the coastal hills just north of Chañaral. It grows in an area where many copiapogas occur, including *C. humilis* var. *taltalensis*, *C. hypogaea* (*mollicula*) and *C. serpentisulcata*. When I saw *C. marginata* var. *bridgesii* at this locality, the plants were very dehydrated, although as the evening approached a thick mist rolled in from the sea which probably explained the dense covering of lichen on the *Eulychnia saint-pieana* which grew all around.





Copiapoa megarhiza

Copiapoa megarhiza Br. & R., The Cact. III:89 (1922)

Synonym: *C. megarhiza* var. *microrhiza* Ritter (1980)

This is one of the earliest members of the genus, described in 1922 by Britton and Rose in Volume 3 of *The Cactaceae* when they erected *Copiapoa* as a genus. It was collected on "very dry granitic hills near Copiapo" by Dr. Rose during his visit to Chile in 1914.

The original description reads: "Plants with large fleshy roots, sometimes 25cm long and 7 to 8cm in diameter, usually single, rarely in 2s and 3s, globular to elongate-cylindric, 8 to 26cm long, 4 to 9cm diameter, dull green to almost white; ribs usually 13, very low; crown of plant covered with long white wool at flowering time; spines about 12, 1.5cm long, rather stout, at first yellow but soon gray; flowers yellow, 2.5cm long; fruit green, 6 to 8mm long, naked, crowned by 5 green scales; seeds black, 2mm long."

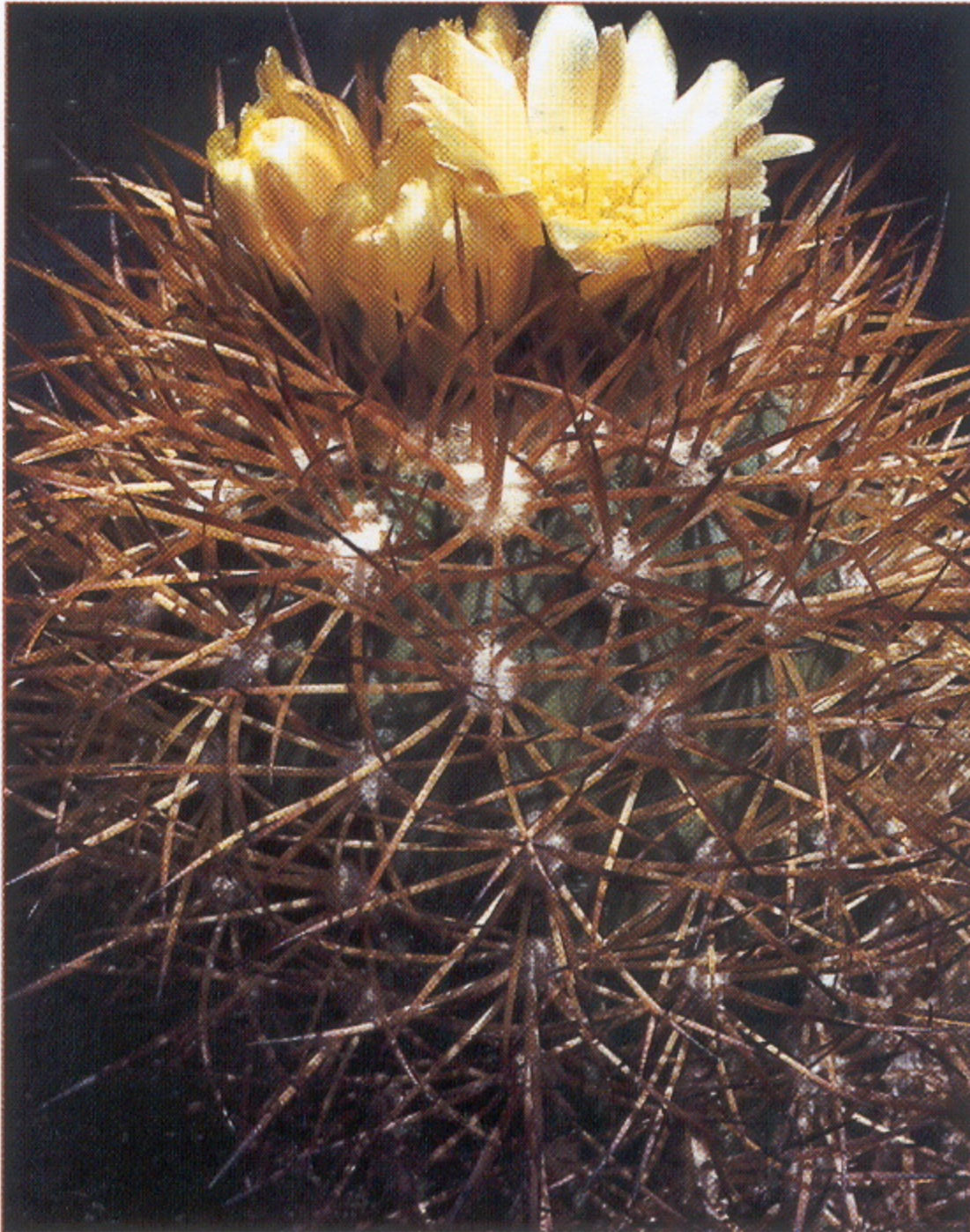
Rare in cultivation, *C. megarhiza* has distinctive golden spines and will flower as a small plant in a 6cm pot. The seedlings grow slowly while they are producing their large underground tuberous root, but given sufficient root space, they make attractive plants.

Like others who had looked before me, I failed to find *C. megarhiza* on the hills near Paipote, east of Copiapo, although they are still there and have been found fairly recently by Roger Ferryman, from whom I obtained the seeds which gave me the cultivation experience recounted above. I have an old, imported specimen of this species (Fig. 86) which had its tuberous root cut off when it was collected; it has been in cultivation for 25 years and has grown only fibrous roots, with no sign of a swollen root being formed. It flowers regularly, although the blooms are quite small and contrast poorly with the yellow spines.

megarhiza
var. megarhiza

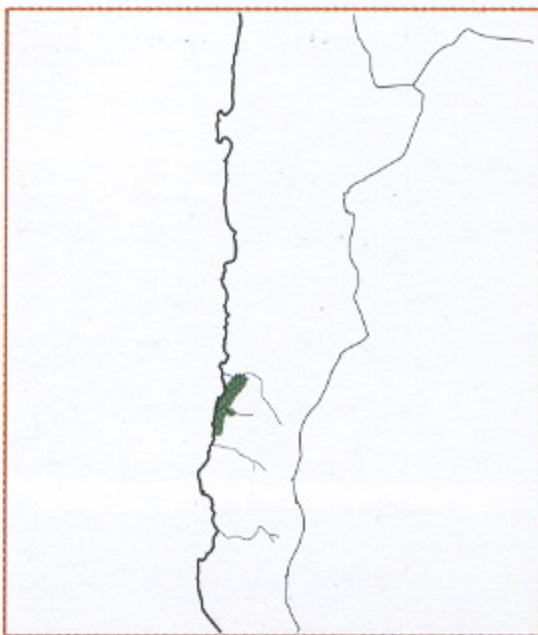
Left Fig.86
Copiapoa megarhiza in
cultivation, ex habitat,
Lau

Right Fig.87
Copiapoa megarhiza in
cultivation, raised from
habitat seed, RMF 129





Left Fig.88
Copiapoa megarhiza showing branched tuberous root, RMF 129
Right Fig.89
Copiapoa megarhiza in habitat at Paipote, TJ 37



megarhiza
var. echinata

Copiapoa megarhiza var. *echinata* (Ritter) Hoffmann, Cact. Fl. Chil. (1989). Basionym: *Copiapoa echinata* Ritter (1959)

Synonyms: *Copiapoa echinata* var. *borealis* Ritter (1959); *C. totoralensis* Ritter (1960)

Hoffmann (1989) reduced Ritter's *C. echinata* to a variety of *C. megarhiza*. She included Ritter's *C. echinata* var. *borealis* in the complex, but did not make it clear whether she regarded it as a separate variety. I include it

here as a synonym of *C. megarhiza* var. *echinata*. Ritter says that both varieties grow together near Paipote — *C. megarhiza* preferring rocks, and his *C. echinata* the flat ground. *C. megarhiza* var. *echinata* should not be confused with *C. echinoides*; the two occur together in habitat in the northern part of the distribution range of *C. echinata*. Both the varieties of *C. megarhiza* are stated by Hoffmann to be vulnerable

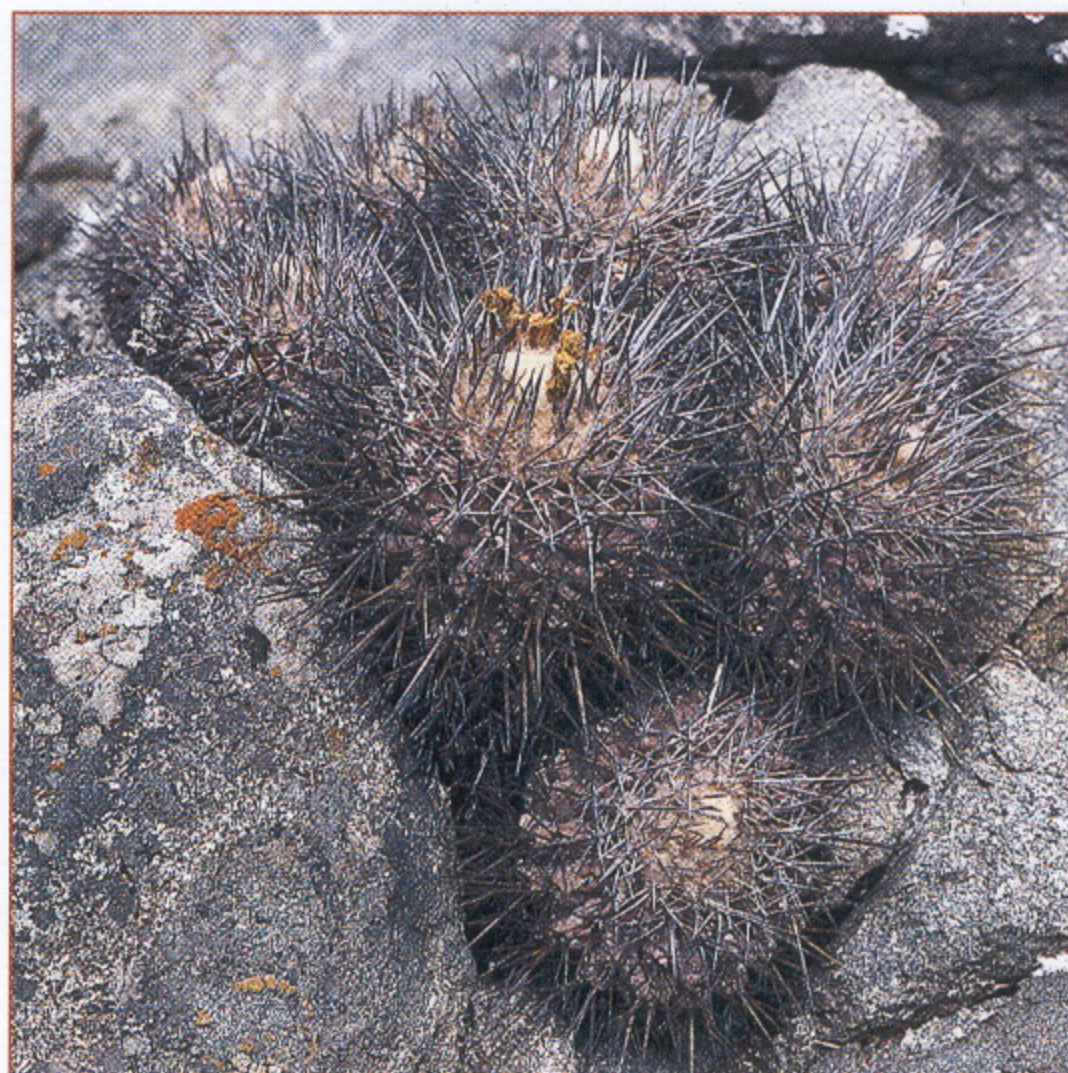


Fig.90
Copiapoa megarhiza
var. *echinata*
(*totoralensis*) in
habitat at Totoral,
RMF 297

Fig.91
Copiapoa megarhiza
var. *echinata* in habitat
21km north of
Huasco Bajo, GC 112.01



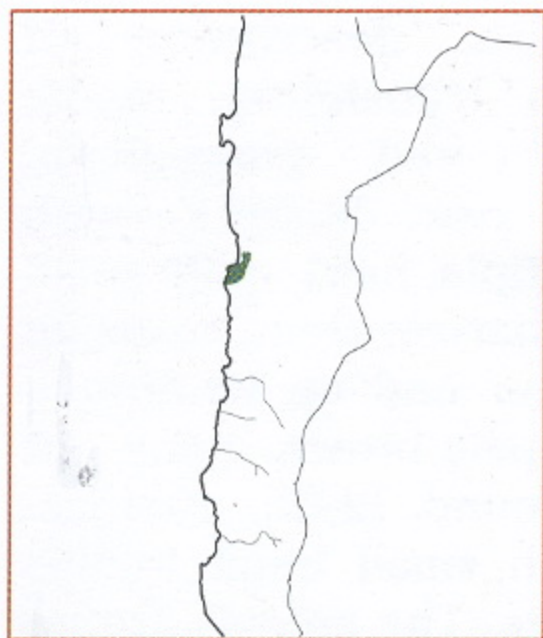
and endangered because of urban expansion and mining work.

C. megarhiza var. *echinata* is even slower growing than the type, and after 10 years may still fit in an 8cm pot at which time it will start to flower. This is the same plant as Ritter's *C. totoralensis*.

Further south, along the coast north of Huasco, in company with *C. echinoides* and *C. cinerea* var. *dealbata*, you can find *C. megarhiza* var. *echinata* forming clumps close to the ground. It appears as a spiny ball, very dehydrated when I saw it, its swollen root helping it to survive the long arid periods. At an even drier inland locality near to Monte Amargo the form Ritter called *C. echinata* var. *borealis* lives in low hills, also forming clumps, but rather smaller. These plants appeared to be on the edge of extinction when I saw them in 1994 — many were already dead. Alan Craig visited the area in 1997 and told me that he found healthier populations at other localities.

Top Fig.92 *Copiapoa megarhiza*
var. *echinata* in cultivation, ex habitat,
RMF 280

Bottom Fig.93 *Copiapoa megarhiza*
var. *echinata* in cultivation, 10 years
old, from habitat seed, PM 225



Copiapoa rupestris

Copiapoa rupestris Ritter, Taxon 12 (1):30 (1963)

Synonyms: *Copiapoa rubriflora* Ritter, Taxon 12 (1):31 (1963); *C. hornilloensis* Ritter (1980); *C. desertorum* Ritter (1980); *C. desertorum* var. *hornilloensis* (Ritter) Hoffmann (1989); *C. desertorum* var. *rupestris* (Ritter) Hoffmann (1989); *C. desertorum* var. *rubriflora* (Ritter) Hoffmann (1989)

This variable species occurs in the hills and plains near to Cifuncho. Its appearance is of a clump or mound of spiny balls. The main claim to fame of *C. rupestris* is that the flower colour can be red, as is the case with the forms named by Ritter as *C. rubriflora* and *C. desertorum*. The latter makes large mounds and can be found on an otherwise barren plain inland from Cifuncho, near to the road to Breas. It is quite a surprise to find it in such a place, and the lack of young plants make one think that it might be a relic population from a time when the area was less arid. All the plants I saw were probably decades old, with no young ones to be seen at all. I assume that the occasional mists are just enough to keep the old plants alive, but have not been enough, for some considerable time, to support the establishment of seedlings.

Top left Fig.94
Copiapoa rupestris
(*desertorum*) in habitat
inland from Cifuncho,
GC 136.01

Top right Fig.95
Copiapoa rupestris in
cultivation, ex habitat,
RMF 154



Left Fig.96 *Copiapoa rupestris* (*desertorum*) in habitat inland from Cifuncho, GC 136.01

Right Fig.97 *Copiapoa rupestris* (San Ramon form) in cultivation, 10 years old, from habitat seed, PM 203

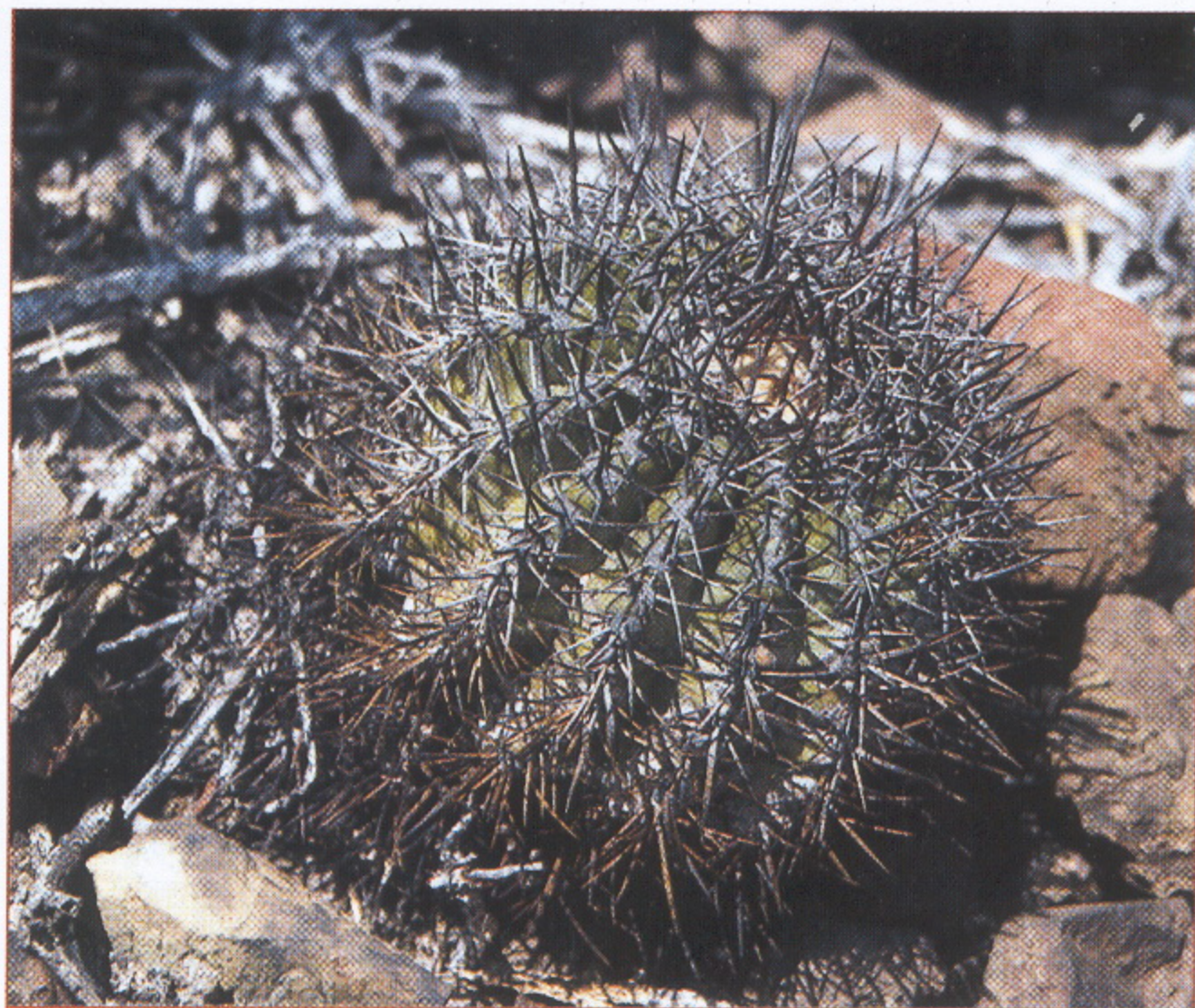


Fig.98
Copiapoa rupestris
(*rubriflora*) in habitat
south of Taltal,
GC 132.02

grey, and in younger plants growing slightly rhomboid in the length and then with 10–15mm spacing, in older heads round, often until they touch one another. Spines: brown, turning grey, awl-shaped, mostly slightly bent downwards, the central spines also straight; radial spines 5–8, 10–25mm long, half directed downwards, lower and upper of the same strength and length, or of decreasing length and strength up the length of the plant. Central spine 1, or occasionally 2–3, 2–4cm long.”

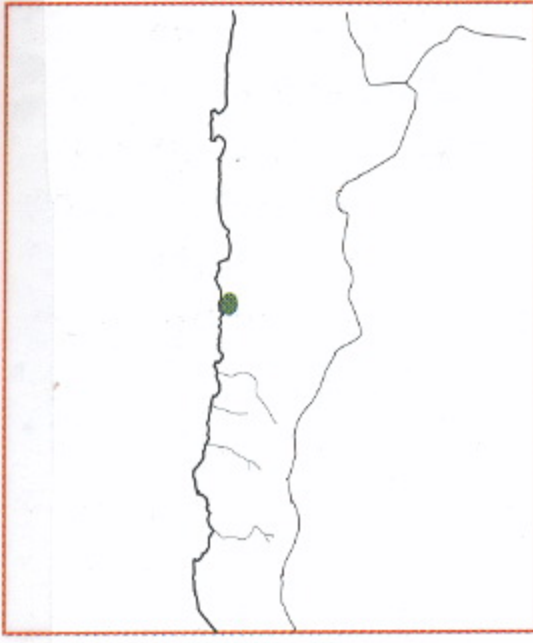
Part of Ritter’s description of *C. rupestris*, in translation, reads: “Body: hard bodied, grass-green, clumping in loose clusters, with tuberous or multiple, hard, quite small taproot without narrow stem; heads up to 11cm diameter and up to around 40cm long with pale brown, spiny, flat crown. Ribs: around 12–15, 10–13cm high, blunt, with small blunt humps under the areoles. The areoles are far apart in younger plants, especially in cultivation, the ribs are thinner between the areoles and often with sharp edges and chin-like under the areoles, and even with a small point directed outwards. In seedlings ribs are divided into humps; quite windy with straight furrows. Areoles: 7–10mm diameter, light-brown felted, becoming



Most of the plants I saw were dehydrated, and many were dead. Near the beach at Cifuncho the plants were small with many single heads. The healthiest were in the hills to the north, just south of Taltal, which I assumed were what Ritter had called *C. rubriflora* although they were not in flower. These were very similar in appearance to the copiapos I found in the Quebrada San Ramon in the company of *C. cinerea* var. *kraenziana* much further to the north. Further exploration would be required to determine whether this latter population is isolated, or if *C. rupestris* in fact occurs continuously between the two localities.

All the forms of *C. rupestris* are uncommon in cultivation, although I am sure growers would like to have the one red-flowered species of *Copiapoa* in their collections, even though it would probably be difficult to flower. My limited experience of growing the various forms suggests that they are slow growing and are rather unexceptional in appearance. Seed is difficult to come by and may only be produced in habitat when the plants receive adequate moisture.

Fig.99 *Copiapoa rupestris* (San Ramon form)
showing tap root, RMF 320



Copiapoa serpentisulcata

Copiapoa serpentisulcata Ritter, Cactus (Paris) 15 (66):22 (1960)

Synonyms: *Copiapoa serpentisulcata* var. *castanea* Ritter (1980)

This is a very interesting and distinct, clump-forming species which occurs in a limited habitat range near to the sea, north of Chañaral.

Part of Ritter's description translates as: "Body: freely clumping, clumps up to 1 metre wide and 60cm high with close heads; these are flat on top, with a pale, yellowy-brown spiny crown, 7–10cm diameter, grey-green, often burnt yellow-brown by the sun, of hard consistency, with a very short, hard, conical, tuberous root without narrowed stem. Ribs: 18–33, wider than high, 5–7mm high, strongly tuberculate, between the tubercles only half the height and thinner, so that furrows are wavy, in particular at the start of the furrows, in older plants the furrows are slightly curved or straight. Areoles: covered in yellowy down, turning grey, round, 3–5mm diameter, somewhat raised, pointing down into notches, 5–8mm apart. Spines: start light brown, turning grey, straight; radial spines 6–8, thick needle shaped to awl-like, 10–15mm long pointing half-outwards, lower spines longest; central spines 1–2(–4), 1–2cm long, awl-shaped."

Fig.100 *Copiapoa serpentisulcata* in habitat north of Chañaral, GC 124.02



Near to Punta Achurra I saw clumps of this plant growing on ground which gently slopes down to the sea; it grows there in the company of *C. cinerascens*, to which it bears a similarity in its habit of growth. The two are, however, easily identifiable as separate species due to the different spine and wool colour. It is interesting to note that I saw no individuals which I considered to be hybrids between the two.

The plants were very dehydrated when I saw them and there were no young plants present. This may be due to collecting activities, since this part of the habitat range of *C. serpentisulcata* is near to the road and it would not take long to explore it and remove the smaller plants. A characteristic which I cannot recall seeing on other copiapoa is the obvious downward-pointing areoles, a feature which is retained on cultivated specimens and makes this species easy to identify. *C. serpentisulcata* is also reported from the hills overlooking this area, where it grows in the company of *C. marginata* var. *bridgesii*. This higher population is probably Ritter's type locality for the species, with his variety *C. serpentisulcata* var. *castanea* growing near to the sea.

In cultivation this species is very rare, probably due to the dry conditions in

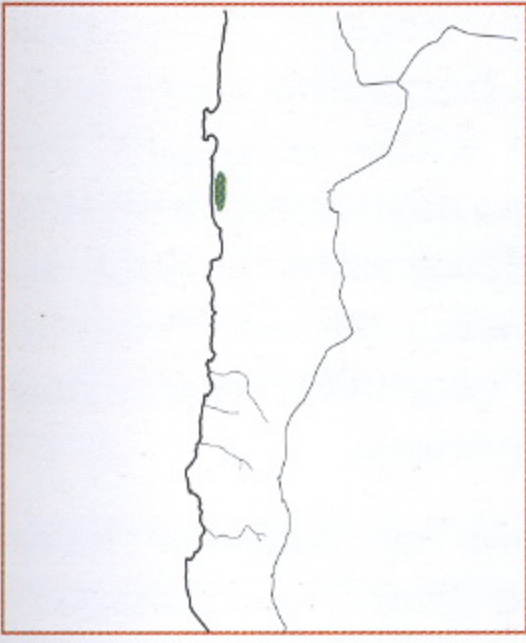
Fig.101 *Copiapoa serpentisulcata* in cultivation, ex habitat, FR 246



Fig.102 *Copiapoa serpentisulcata* in habitat north of Chañaral, GC 124.02

habitat preventing the formation of seeds. In addition, the few plants in cultivation which are available to produce seed rarely flower. Only a few plants have been imported, even by Karel Knize, perhaps because there were few small plants to remove from habitat. Plants distributed by Knize as *C. goldii* nom. nud. are probably a form of this species.





Copiapoa solaris

Copiapoa solaris (Ritter) Ritter, Kakt. Südamer. 3:1047-8 (1980).

Basionym: *Pilocopiapoa solaris* Ritter (1961)

Synonyms: *Copiapoa ferox* Lembcke & Backbg. ex Backbg. nom. inval. (1959); *C. conglomerata* (Philippi) Lembcke (1966)

This is a very distinct species from the northern part of the *Copiapoa* habitat range. It is likely that the first attempt at describing this species was made by Philippi in 1860 as *Echinocactus conglomeratus* — the habitat locality was accurately given and the specific name is appropriate. Unfortunately, Philippi's description which constitutes the type for the name is not a description of this plant, an unfortunate error which makes the later combination by Lembcke (1966) of *Copiapoa conglomerata* illegitimate. The description of the same species by Lembcke and Backeberg in *Die Cactaceae* (1959) as *Copiapoa ferox* was also invalid because of the lack of a valid type specimen. The first valid description of this plant was published by Ritter in *KuaS* (1961) when he published *Pilocopiapoa solaris* as the sole species in his new genus *Pilocopiapoa*. This genus was based on a number of minor differences, notably the woolly covering on the receptacle. The species was subsequently placed in *Copiapoa* by Ritter (1980) when he reduced *Pilocopiapoa* to a subgenus.

In *Kakteen in Südamerika*, Ritter makes the interesting statement that *C. solaris* grows at its best above the mist zone and that it depends on occasional rain for survival. He goes on to say that on one occasion when visiting the plants, the ground was still wet from recent heavy rainfall. We

Fig.103
Copiapoa solaris
in habitat 8km south
of Blanco Encalada



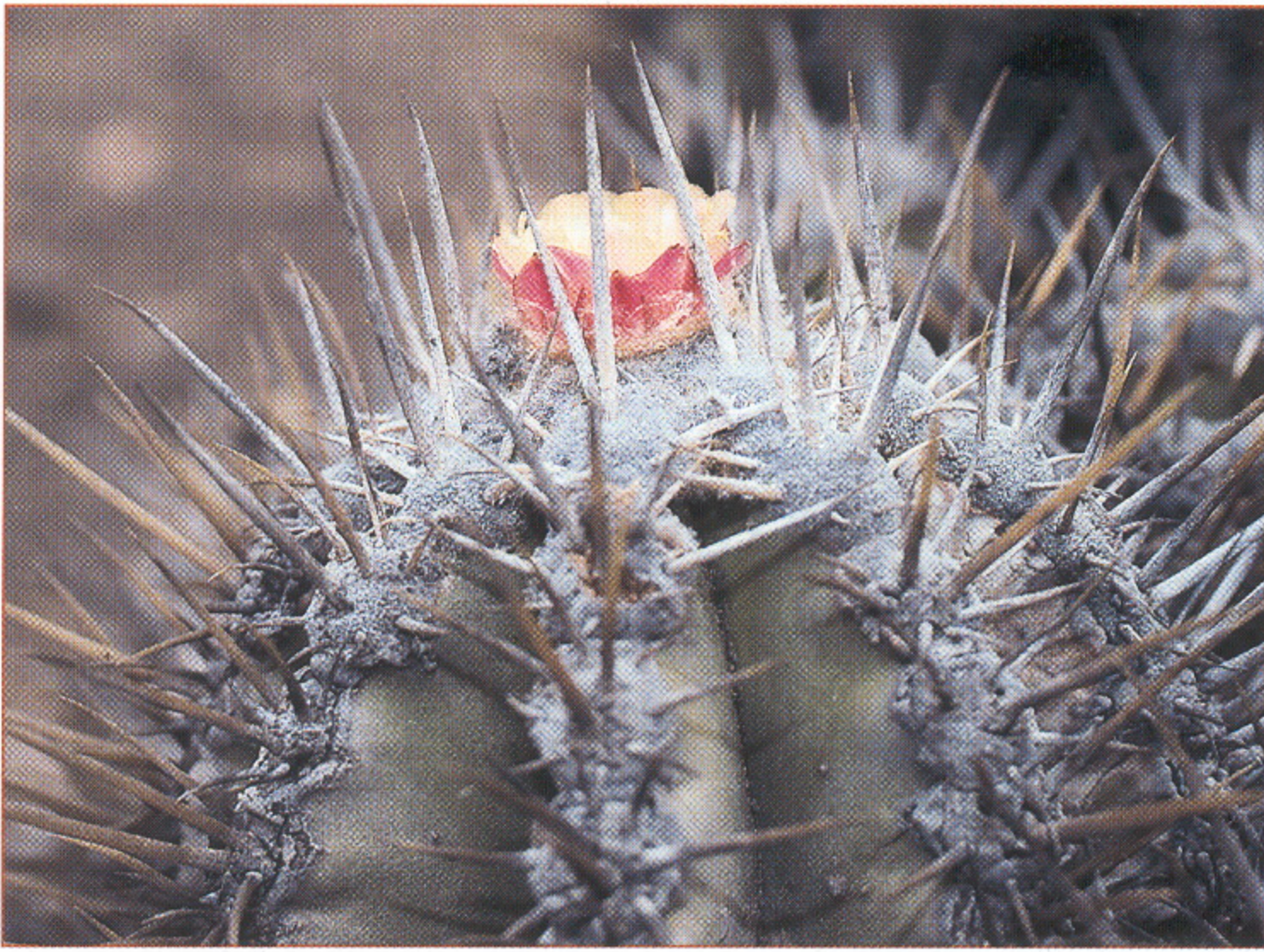


Fig.104
Copiapoa solaris
in habitat east of
El Cobre

strongest of any *Copiapoa*. The seeds are larger than other species and are contained in larger fruits with thicker walls.

Copiapoa solaris is predominantly a mountain species, extending from 600m to over 1,000m altitude, where the populations can be very large. Its distribution in habitat from about 50km north of Paposo northwards at

generally accept that this region is becoming more arid, but even Ritter mentions the eulychnias associated with this species dying from drought, so perhaps what we see today is just part of a cycle of dry and less dry periods.

A number of authors have suggested that the characteristics which made Ritter place this species in a separate genus point to this being the most primitive *Copiapoa*. In its habitat it can form very large clusters up to 2 metres in diameter and 1 metre high, composed of hundreds of heads. Its spination is the

least to El Cobre is probably fairly continuous, with plants in the south being generally healthier than those in the north which are suffering from extreme dryness and are slowly being eradicated. The large clumps are a prominent feature on the otherwise bare hillsides, although close inspection reveals that many are dead. This species often grows with *C. atacamensis* which, with its tuberous roots, is even better adapted to the extreme aridity of the area.

In cultivation this species is uncommon due to its slow growth and the lack of available seed. I have not heard of plants flowering in cultivation in Europe and habitat seed is rarely offered, so it is unlikely to become more widely grown. Although slow, it will form clumps from a small size and, with careful culture, strong spines can be maintained.



Fig.105
Copiapoa solaris, 30 years in
cultivation, ex habitat

FIELD COLLECTORS' NUMBERS

Some plant enthusiasts have visited the habitats of *Copiapoa* and allocated numbers to the plant populations they found. The following lists the numbers of eight such people with the identification they attributed and the locality they published. Many of the names do not correspond with those which I have used in this book, reflecting the confusion surrounding the nomenclature of this genus.

If you see plants in cultivation bearing these numbers, there is usually no way of determining how many generations separate the individuals from the original collection of seed or plants. The 'Chileans', a society for the study of South American cacti, has published a code to help establish authenticity in cultivated plants. The field number is followed by a letter in parentheses with the following meaning:

(H) = Cutting of habitat plant

(Z) = Grown from seed pollinated in habitat

(Y) = Grown from seed collected from the pollination of habitat plants in cultivation

The lists show *Copiapoa* collections made by the following:

Roger Ferryman is well known in Britain, having made numerous trips to Chile, principally to study *Neoporteria*. Plants in cultivation will usually have been grown from seed which Roger collected in habitat or from plants in his collection.

Tom Jenkins, a famous British nurseryman and BCSS Official, who visited Chile and later distributed seedlings from seed collected off the plants he brought back from his trip.

Fred Kattermann, another frequent visitor to Chile, has distributed seeds from pollination of plants he collected in the wild.

Karel Knize runs a commercial nursery in Lima, Peru, and has probably been responsible for the sale of more wild collected plants than anyone. Large numbers of habitat *copiapoas* were imported into Europe in the 1970s and 80s, and many mature plants in collections today probably result from this activity. Imported plants from Knize have not always been reliably identified and his field list contains many names invented by him for minor variations. My experience with his seeds is also mixed, with resultant plants sometimes not being the right species or even the correct genus.

Alfred Lau distributed large numbers of habitat collected plants in the early 70s and many can still be found in collections today. He was probably the best supplier to European nurseries at that time and his identifications are generally good.

Ken Preston-Mafham accompanied me on my trip to Chile, having already been there some years earlier. All plants in cultivation with his numbers which were distributed by him are from habitat collected seed. This is also true of plants with my GC numbers.

Friedrich Ritter has probably done more for South American cacti in recent years than anyone. His travels in the 1960s and 70s resulted in many new discoveries, although he favoured creating more names for different forms than is fashionable today. Volume 3 of his *Kakteen in Südamerika* about Chilean cacti is essential reading for any enthusiast of *Copiapoa*.

Graham Charles (GC)

GC No.	Name	Locality
GC 91.01	<i>coquimbana</i> (<i>wagenknechtii</i>)	Elqui Valley
GC 92.01	<i>coquimbana</i> (<i>wagenknechtii</i>)	Vicuna
GC 96.01	<i>coquimbana</i>	Punta Hornus
GC 96.05	<i>coquimbana</i>	El Chirposa
GC 97.01	<i>coquimbana</i> (<i>pseudocoquimbana</i>)	S El Trapiche
GC 98.01	<i>coquimbana</i> (<i>pseudocoquimbana</i>)	E El Trapiche
GC 99.01	<i>coquimbana</i> (<i>vallenarensis</i>)	S Vallenar
GC 102.01	<i>coquimbana</i> (golden spines)	km39, Transito valley
GC 107.01	<i>coquimbana</i> (<i>alticostata</i>)	E Freirina
GC 108.01	<i>coquimbana</i> (<i>alticostata</i>)	E Freirina
GC 109.01	<i>coquimbana</i> var. <i>fiedleriana</i>	E Huasco
GC 111.01	<i>echinoides</i>	N Huasco Bajo
GC 112.01	<i>megarhiza</i> var. <i>echinata</i>	N Huasco Bajo
GC 113.01	<i>cinerea</i> var. <i>dealbata</i>	N Huasco Bajo
GC 113.02	<i>echinoides</i>	N Huasco Bajo
GC 113.03	<i>megarhiza</i> var. <i>echinata</i>	N Huasco Bajo
GC 114.01	<i>cinerea</i> var. <i>dealbata</i>	N Huasco Bajo
GC 115.01	<i>echinoides</i>	N Huasco Bajo
GC 115.02	<i>megarhiza</i> var. <i>echinata</i>	N Huasco Bajo
GC 116.01	<i>cinerea</i> var. <i>dealbata</i>	N Carrizal Bajo
GC 117.01	<i>cinerea</i> var. <i>dealbata</i>	N Carrizal Bajo
GC 117.02	<i>echinoides</i>	N Carrizal Bajo
GC 117.03	<i>megarhiza</i> var. <i>echinata</i>	N Carrizal Bajo
GC 117.04	<i>cinerea</i> var. <i>dealbata</i>	N Carrizal Bajo
GC 118.01	<i>echinoides</i>	W Totoral
GC 119.01	<i>echinoides</i>	E Totoral
GC 120.01	<i>calderana</i>	N Caldera
GC 121.01	<i>calderana</i>	N Caldera
GC 122.01	sp. (with golden spines)	S Chanaral
GC 123.01	<i>marginata</i> var. <i>bridgesii</i>	N Chanaral
GC 123.02	<i>hypogaea</i> (<i>mollicula</i>)	N Chanaral
GC 124.01	<i>cinerascens</i>	N Chanaral
GC 124.02	<i>serpentsulcata</i>	N Chanaral
GC 125.01	<i>cinerascens</i>	S Pan de Azucar
GC 126.01	<i>cinerascens</i>	Pan de Azucar
GC 126.02	<i>cinerea</i> var. <i>columna-alba</i>	Pan de Azucar
GC 127.01	<i>cinerea</i> var. <i>columna-alba</i> (<i>melanohystrix</i>)	Esmeralda
GC 127.02	<i>cinerascens</i> var. <i>grandiflora</i>	Esmeralda
GC 129.01	<i>humilis</i> var. <i>esmeraldana</i>	Esmeralda
GC 129.02	<i>cinerascens</i> var. <i>grandiflora</i>	Esmeralda
GC 129.03	<i>hypogaea</i> var. <i>laui</i>	Esmeralda
GC 129.04	<i>cinerea</i> var. <i>longistaminea</i>	Esmeralda
GC 130.01	<i>cinerea</i>	Breas
GC 131.01	<i>cinerea</i> forms	Quebrada San Roman
GC 131.02	<i>cinerea</i> var. <i>krainziana</i>	Quebrada San Roman
GC 131.03	<i>rupestris</i>	Quebrada San Roman
GC 132.01	<i>cinerea</i> var. <i>gigantea</i>	Paposo
GC 132.02	<i>humilis</i>	Paposo
GC 133.01	<i>cinerea</i> var. <i>gigantea</i>	S Paposo
GC 134.01	<i>cinerea</i>	E Taltal
GC 135.01	<i>cinerea</i> var. <i>columna-alba</i>	S Taltal
GC 135.02	<i>rupestris</i> (<i>rubriflora</i>)	S Taltal
GC 136.01	<i>rupestris</i> (<i>desertorum</i>)	E Cifuncho
GC 137.01	<i>rupestris</i>	Cifuncho
GC 138.01	<i>marginata</i>	Morro Copiapo
GC 139.01	<i>megarhiza</i> var. <i>echinata</i> (<i>borealis</i>)	Monte Amargo
GC 140.01	<i>coquimbana</i> (<i>vallenarensis</i>)	S Vallenar
GC 141.01	<i>coquimbana</i> (<i>domeykoensis</i> n.n.)	SW Domeyko

Roger Ferryman (RMF)

RMF No.	Name	Locality
RMF 8	<i>coquimbana</i>	S Vallenar
RMF 9	<i>calderana</i>	Caldera
RMF 10	<i>marginata</i>	Caldera
RMF 39	<i>boliviana</i>	Cerro Moreno 0-300m
RMF 41	<i>solaris</i>	El Cobre 650m
RMF 44	<i>solaris</i>	Blanco Encalada 600m
RMF 46	<i>boliviana</i>	Blanco Encalada 600m
RMF 47	<i>haseltoniana</i>	Blanco Encalada to Paposo
RMF 48	<i>haseltoniana</i>	Blanco Encalada to Paposo
RMF 49	<i>haseltoniana</i>	Blanco Encalada to Paposo
RMF 50	<i>haseltoniana</i>	Paposo sea level
RMF 51	<i>haseltoniana</i>	Paposo sea level
RMF 52	<i>haseltoniana</i>	Paposo sea level
RMF 53	sp.	Caleta Botija, N Paposo
RMF 62	<i>cinerea</i> var. <i>albispina</i>	Taltal
RMF 63	<i>cinerea</i>	La Cachina, Taltal
RMF 77	<i>pseudocoquimbana</i>	Trapiche 400m
RMF 94	<i>hypogaea</i> var. <i>barquitis</i>	Barquito 100m
RMF 116	<i>coquimbana</i> fa. <i>wagenknechtii</i>	E. La Serena
RMF 125	<i>vallenarensis</i>	Vallenar 600m
RMF 129	<i>megarhiza</i>	Paipote 400m
RMF 132	cf. <i>hypogaea</i>	Caldera
RMF 133	<i>bridgesii</i>	N. Caldera
RMF 136	<i>calderana</i>	N. Caldera
RMF 139	<i>humilis</i>	Paposo 350m
RMF 146	<i>haseltoniana</i>	Paposo
RMF 147	<i>haseltoniana</i>	8 km N. Paposo
RMF 150	<i>olivana</i>	Caleta Oliva
RMF 152	<i>tenebrosa</i>	Taltal - Cifuncho 220m
RMF 153	<i>desertorum</i>	Taltal - Cifuncho 220m
RMF 154	<i>rupestris</i>	Cifuncho
RMF 157	<i>columna-alba</i>	Esmeralda 100m
RMF 158	<i>grandiflora</i>	Esmeralda 100m
RMF 160	<i>longistaminea</i>	Esmeralda 100m
RMF 161	<i>esmeraldana</i>	Esmeralda 100m
RMF 162	<i>laui</i>	Esmeralda 100m
RMF 164	<i>grandiflora</i>	Esmeralda 100m
RMF 166	<i>cinerea</i>	Pan de Azucar
RMF 168	<i>cinerascens</i>	Pan de Azucar
RMF 169	<i>grandiflora</i>	Pan de Azucar
RMF 170	<i>mollicula</i>	Chanaral 50m
RMF 172	<i>marginata</i>	30 km N. Caldera
RMF 174	<i>mollicula</i>	Monte Amargo
RMF 178	<i>vallenarensis</i>	Maitencillo 300m
RMF 183	<i>fiedleriana</i>	Huasco
RMF 190	<i>coquimbana</i> var. <i>armata</i>	Cruze Grande
RMF 271	<i>pseudocoquimbana</i>	
RMF 275	<i>alticostata</i>	S. Freirina 200m
RMF 278	<i>carrizalensis</i>	Carrizal Bajo
RMF 280	<i>echinus</i>	N. Carrizal Bajo
RMF 285	<i>echinus</i>	Caleta de los Buros 150m
RMF 286	<i>cuprea</i>	Totoral
RMF 291	<i>dura</i>	Punta Totoral
RMF 295	<i>dura</i>	Totoral Bajo
RMF 297	<i>echinus</i>	Totoral - Carrizal Bajo
RMF 298	<i>dura</i>	W. Canto del Agua 400m
RMF 312	<i>tocopillana</i>	Tocopilla
RMF 316	<i>boliviana</i>	Morro Moreno 300m
RMF 318	<i>tenuissima</i>	El Cobre 650m
RMF 319	<i>krainziana</i>	San Ramon, Taltal
RMF 320	<i>rubriflora</i>	San Ramon, Taltal
RMF 324	<i>laui</i> fa.	Pan de Azucar
RMF 328	sp.	Pan de Azucar
RMF 329	<i>cinerascens</i>	Pan de Azucar
RMF 331	<i>serpentsulcata</i>	Chanaral
RMF 335	<i>cinerascens intermedia</i>	Barquito
RMF 337	<i>marginata</i>	Morro Copiapo
RMF 344	<i>dura</i>	Totoral Bajo - Carrizal Bajo
RMF 345	<i>carrizalensis</i>	Carrizal Bajo

Tom Jenkins (TJ)

TJ No.	Name	Locality
TJ 22	<i>coquimbana</i>	Coquimbo bay
TJ 30	<i>pseudocoquimbana</i>	Trapiche
TJ 34	<i>vallenarensis</i>	8km S Vallenar
TJ 37	<i>megarhiza</i>	Paipote
TJ 40	<i>mollicula/barquitenensis</i>	3km E Qu. Los Leones
TJ 41	sp.	3km E Qu. Los Leones
TJ 45	<i>calderana</i>	N Caldera
TJ 49	<i>cinerea</i>	Taltal
TJ 50	<i>cinerea albispina</i>	8km N Taltal
TJ 51	<i>gigantea</i>	20km N Taltal
TJ 53	<i>humilis</i>	Paposo 300m
TJ 55	<i>humilis longispina</i>	Paposo 700m
TJ 59	<i>haseltoniana</i>	8km N Paposo
TJ 60	<i>olivana</i>	Quebrada Oliva
TJ 64	<i>tenebrosa</i>	Taltal – Cifuncho
TJ 65	<i>desertorum/rubriflora</i>	Taltal – Cifuncho
TJ 68	<i>columna-alba</i>	Caleta Esmeralda
TJ 69	<i>grandiflora</i>	Caleta Esmeralda
TJ 71	<i>laui</i>	Caleta Esmeralda
TJ 72	<i>longistaminea</i>	Caleta Esmeralda
TJ 77	<i>cinerea</i>	Pan de Azucar
TJ 78	<i>esmeraldana</i>	Caleta Esmeralda 150m
TJ 81	<i>mollicula</i>	Chanaral 200/300m
TJ 82	<i>hypogaea</i>	Chanaral 200/300m
TJ 83	<i>marginata</i>	30km N Caldera
TJ 84	sp.	Copiapo – Caldera 200m
TJ 87	<i>vallenarensis</i>	Maitencillo – Huasco 300m
TJ 91	<i>fiedleriana</i>	Huasco, sea level

Fred Kattermann (FK)

FK No.	Name	Locality
FK 9	<i>pendulina</i>	Las Palmas, Coquimbo
FK 23a	<i>pendulina</i>	Punta Lengua de Vaca
FK 25	<i>pendulina</i>	Punta Lengua de Vaca 10m
FK 26	<i>wagenknechtii</i>	15km E La Serena 100m
FK 32	<i>calderana</i>	N Caldera 10m
FK 33	<i>haseltoniana</i>	Paposo 20m
FK 35	<i>humilis</i>	10km N Paposo 75m
FK 37	<i>cinerea</i>	E Breas 250m
FK 38	<i>rubriflora</i>	Taltal-Cifuncho 600m
FK 39	<i>columna-alba</i>	Cifuncho 50m
FK 40	<i>desertorum</i>	Cifuncho 30m
FK 41	<i>cinerea</i> var.	E Pan de Azucar
FK 42	<i>cinerascens</i>	Pan de Azucar 10m
FK 43	<i>cinerascens</i>	S Pan de Azucar 20m
FK 44	<i>serpentisulcata</i>	10km N Chanaral 10m
FK 46	<i>calderana</i> var. <i>spinosior</i>	Chanaral 30m
FK 47	<i>dura</i>	Estancia Castilla 350m
FK 48	<i>echinata</i>	W Totoral 200m
FK 49	<i>echinoides</i>	W Totoral 200m
FK 50	<i>carrizalensis</i>	S Totoral 50m
FK 51	<i>echinoides</i>	S Totoral 40m
FK 55	<i>dura</i>	Totoral – Canto de Agua 500m
FK 56	<i>dealbata</i>	S Carrizal Bajo 40m
FK 57	<i>echinata</i> var. <i>borealis</i>	S Carrizal Bajo 40m
FK 59	<i>echinoides</i>	S Carrizal Bajo 40m
FK 60	<i>dura</i>	W Canto de Agua 200m

FK No.	Name	Locality
FK 64	<i>cuprea</i>	S Canto de Agua 700m
FK 66	<i>alticostata</i>	N Freirina 800m
FK 68	<i>alticostata</i>	N Freirina 200m
FK 73	<i>fiedleriana</i>	N Huasco 10m
FK 83	<i>pseudocoquimbana</i>	W Trapiche 200m
FK 94	<i>dura</i>	Castilla
FK 106	<i>domeykoensis</i>	S Vallenar 500m
FK 107	<i>cinerea</i>	? Paposo
FK 111	<i>humilis</i>	N Paposo 300m
FK 115	<i>haseltoniana</i>	N Taltal 20m
FK 120	<i>serpentisulcata</i>	Cifuncho 10m
FK 121	<i>columna-alba</i>	Cifuncho
FK 122	<i>desertorum</i>	Cifuncho 50m
FK 123	<i>columna-alba</i> var.	SE Cifuncho 50m
FK 125	<i>columna-alba</i>	Pan de Azucar 50m
FK 126	<i>cinerascens</i>	Pan de Azucar 25m
FK 128	<i>cinerascens</i>	N Chanaral 25m
FK 129	<i>serpentisulcata</i>	N Chanaral 20m
FK 131	<i>bridgesii</i>	N Chanaral 100m
FK 133	<i>hypogaea</i>	N Chanaral 200m
FK 134	<i>calderana</i>	
FK 137	<i>mollicula</i>	N Chanaral 250m
FK 138	<i>calderana</i>	N Caldera 20m
FK 142	<i>megarhiza</i>	5km E Copiapo 500m
FK 145	<i>echinata</i>	W Totoral Bajo 200m
FK 146	<i>echinata</i>	Totoral 200m
FK 152	<i>dura</i>	E Carrizal 200m
FK 157	<i>cuprea</i>	S Canto de Agua 700m
FK 161	<i>coquimbana</i>	S Freirina 300m
FK 168	<i>vallenarensis</i>	E Vallenar 800m
FK 172	<i>vallenarensis</i>	Mina Algarrobo 500m
FK 175	<i>domeykoensis</i>	W Domeyko 750m
FK 219	<i>pseudocoquimbana</i>	Domeyko
FK 220	<i>domeykoensis</i>	Domeyko
FK 325a	<i>intermedia</i>	Barquito
FK 327	<i>coquimbana</i>	N La Serenna
FK 372	<i>atacamensis</i>	Morro Moreno 610m
FK 375	<i>solaris</i>	El Cobre 915m
FK 376	<i>atacamensis</i>	El Cobre 152m
FK 377	<i>atacamensis</i>	Blanco Encalada 610m
FK 378	<i>solaris</i>	Blanco Encalada 610m
FK 382	<i>variispina</i>	Blanco-Encalada – Paposo 20m
FK 383	<i>gigantea</i>	N Paposo
FK 384	<i>haseltoniana</i>	30km S Paposo
FK 390	<i>albispina</i>	N Taltal
FK 393	<i>barquitensis</i>	Barquito 610m
FK 395a	<i>cinerascens</i> var. <i>intermedia</i>	S Barquito
FK 403	<i>pseudocoquimbana</i>	Trapiche
FK 439	<i>laui</i>	Esmeralda
FK 441	<i>esmeraldana</i>	Esmeralda
FK 444	<i>mollicula</i>	Agua Leone
FK 445	<i>mollicula</i>	Chanaral
FK 463	<i>wagenknechtii</i>	El Tambo
FK 464	<i>coquimbana</i>	Domeyko – Sarco
FK 488	<i>montana</i>	E Taltal
FK 490	<i>olivana</i>	N Taltal
FK 491	<i>cinerea</i> var. <i>albispina</i>	N Taltal
FK 492	<i>gigantea</i>	Agua Cascabeles
FK 493	<i>eremophila</i>	Paposo 610m
FK 494	<i>cinerea</i> var. <i>albispina</i>	Agua Cascabeles
FK 497	<i>olivana</i>	N Taltal
FK 498	<i>montana</i>	N Taltal
FK 500	<i>krainziana</i>	Qu. San Ramon

FK No.	Name	Locality
FK 502	<i>tenebrosa</i>	Qu. San
FK 507	<i>longistaminea</i>	Qu. Huanillos
FK 508	<i>grandiflora</i>	Qu. Huanillos
FK 509	<i>taltalensis</i>	Esmeralda
FK 512	<i>longispina</i>	S Chanaral
FK 518	<i>calderana</i>	Caldera
FK 521	<i>echinata</i>	SE Caldera
FK 523	<i>echinata</i> var. <i>borealis</i>	Monte Amargo - Puerto Viejo
FK 527	<i>echinata</i> var. <i>borealis</i>	N Totoral, Sea level
FK 530	sp.	Algarrobal
FK 532	<i>coquimbana</i> var. <i>armata</i>	Tres Cruces - Junta de Chingolos 457m
FK 563	<i>megarhiza</i>	Paipote
FK 766a	<i>bridgesii</i>	Agua Leone
FK 767	<i>mollicula</i>	Agua Leone
FK 770	<i>calderana</i>	N Caldera
FK 775	<i>tocopillana</i>	S Tocopilla
FK 779	<i>tenuissima</i>	El Cobre
FK 782	<i>variispina</i>	Paposo
FK 783	<i>krainziana</i>	Taltal, Quebrada Ramon 366m
FK 784	? <i>taltalensis</i>	Quebrada Ramon 366m
FK 787	<i>krainziana</i>	Quebrada Ramon 366m
FK 788	<i>krainziana</i>	Quebrada Ramon
FK 789	<i>tenebrosa</i>	Quebrada Ramon 366m
FK 791	<i>esmeraldana</i>	Pan de Azucar
FK 793	aff. <i>esmeraldana</i>	Pan de Azucar 762m
FK 794	<i>laui</i>	Pan de Azucar 762m
FK 796	<i>grandiflora</i>	Esmeralda
FK 799	<i>serpentisulcata</i>	20km N Chanaral
FK 805	<i>marginata</i>	Morro Copiapo
FK 809	<i>megarhiza</i>	E Paipote
FK 819	<i>vallenarensis</i>	Transito 762m
FK 833	<i>echinata</i> var. <i>borealis</i>	SW Monte Amargo
FK 834	<i>solaris</i>	El Cobre
FK 835	<i>bridgesii</i>	Morro Copiapo
FK 836	<i>marginata</i>	

Karel Knize (KK) (Early numbers sometimes shown with KZ prefix)

KK No.	Name	Locality
KK 1	<i>coquimbana</i>	Cerro Grande, La Serena 400m (800m)
KK 1a	<i>coquimbana</i> fa.	Algarrobito
KK 10	<i>pseudocoquimbana</i> var. <i>vulgata</i>	Coquimbo, Herradura 100m
KK 10a	<i>pseudocoquimbana</i> fa.	Coquimbo, Herradura 200m
KK 14	<i>pseudocoquimbana</i> fa.	Trapiche 600m (800m)
KK 14a	<i>pseudocoquimbana</i> fa.	Trapiche - Choros 800m
KK 14b	<i>pseudocoquimbana</i> fa.	Choros 300m
KK 16	<i>alticostata</i>	Freirina 400-500m (300m)
KK 16a	<i>alticostata</i> var. <i>minima</i> n.n.	Freirina 200m
KK 16b	<i>malletiana</i>	Nicolasa 400m
KK 21	<i>cupreata</i>	Agua Verde 500m
KK 22	<i>coquimbana</i> var.	Juan Soldado 500m
KK 30	<i>totalensis</i>	Totoral 300m
KK 34	<i>desertorum</i>	Huasco 200m
KK 35	<i>cupreata</i> var. ?	Huasco Bajo 100-300m
KK 38	<i>carrizalensis</i>	Carrizal Bajo 200-300m
KK 41	sp. (= <i>C. desertorum</i> ?)	2km east Huasco 200m
KK 43	<i>imbricata</i> n. n. (near <i>C. aureispina</i> ?)	Mina Magarita, Coquimbo 700m (1000m)
KK 44	<i>microcarpa</i> n. n. (var. of <i>C. coquimbana</i> ?)	Mina Islon 800m
KK 46	<i>coquimbana</i> var. <i>microsperma</i> n.n.	Islon 600m
KK 57	<i>imbricata</i> var. <i>rubriflora</i> n.n.	El Molle, Rio Elqui 700m (Vicuna 800m)

KK No.	Name	Locality
KK 58	<i>wagenknechtii</i>	Vicuna 500-600m
KK 69	<i>haseltoniana</i>	Paposo 100-200m
KK 70	<i>lembckeii</i> (= <i>C. cinerascens</i> ?)	Caldera 100-200m
KK 71	<i>barquitensis</i>	Barquito 200-300m
KK 72	<i>streptocaulon</i> (= <i>C. marginata</i> ?)	Cerro Moreno, Antofagasta 600m
KK 77	<i>cinerea</i>	Taltal 300-600m
KK 80	<i>gigantea</i>	(km 15) Paposo – Taltal 100-200m (500m)
KK 86	<i>pseudocoquimbana</i>	Trapiche 600m
KK 87	<i>wagenknechtii</i> var.	El Molle, Rio Elqui 600m
KK 88	<i>hypogaea</i>	Chanaral 300-400m
KK 88a	<i>hypogaea</i>	Chanaral 300m
KK 89	<i>rubriflora</i>	Esmeralda 100-300m
KK 90	<i>marginata</i> (= <i>C. streptocaulon</i> ?)	El Cobre 600m
KK 91	<i>vallenarensis</i> n.n.	Vallenar 700m
KK 92	<i>cinerea</i> var.	Taltal 100-200m
KK 93	sp.	(km 20) Vallenar (interior) 800m (900m)
KK 93a	sp.	Vallenar (interior) 900m
KK 94	<i>echinoides</i>	Antofagasta 600m
KK 102	<i>imbricata</i> n.n.	El Molle, Rio Elavi 600m
KK 103	<i>wagenknechtii</i>	El Molle, Rio Elqui 800m
KK 109	<i>megarhiza</i>	Copiapo 600-700m (800m)
KK 109a	<i>megarhiza</i> var.	Copiapo, Monte Amargo 600m
KK 112	<i>chanaralensis</i>	Chanaral 200m
KK 116	<i>wagenknechtii</i>	El Molle 600m
KK 118	<i>humilis</i>	Paposo 500m
KK 172	<i>fiedleriana</i>	Nicolasa 500m
KK 173	<i>marginata</i> var. <i>magnifica</i> n.n.	El Cobre 600m
KK 174	<i>ferox</i>	Blanco Encalada 600m
KK 176	<i>cinerascens</i>	Caldera 100-200m
KK 183	<i>coquimbana</i> var. <i>longispina</i> n.n.	La Serena 300m
KK 185	<i>krainziana</i>	Taltal 400-500m (300-400m)
KK 188	<i>cuprea</i>	Nicolasa 600m
KK 194	<i>longistaminea</i>	Cifuncho 200m
KK 195	<i>rupestris</i>	Cifuncho 100-200m
KK 196	<i>grandiflora</i>	Carrizal Alto 600m
KK 198	<i>dura</i>	Castilla 700-800m (1000m)
KK 199	<i>echinata</i>	Copiapo 800m
KK 601	<i>minuta</i> n.n.	Mina Carrizal 600m
KK 602	<i>chanaralensis</i>	Chanaral 300-400m (100m)
KK 603	<i>goldii</i> n.n.	Chanaral – Esmeralda 200m
KK 607	<i>dura</i>	Totoral 200-300m
KK 608	<i>cinerea</i> var. <i>dealbata</i>	Carrizal Bajo 400m
KK 609	<i>dealbata</i> fa. <i>longispina</i> n.n.	Carrizal Alto 500-600m
KK 610	<i>cinerea</i> var. <i>albispina</i>	Taltal (km 12) 100-200m
KK 611	<i>cinerea</i> var. <i>columna-alba</i>	Cifuncho 300m
KK 612	<i>rupestris</i>	Cifuncho – Taltal coast 200m (100m)
KK 613	<i>serpentisulcata</i> fa.	Paposo – Taltal 300m
KK 614	<i>gigantea</i>	Paposo 100-300m (800m)
KK 618	<i>pepiniana</i>	Maitencillo 600m
KK 619	<i>fiedleriana</i>	Nicolasa 600m
KK 620	<i>ferox</i>	Blanco Encalada 300m
KK 623	<i>serpentisulcata</i>	Chanaral – Esmeralda 100-200m
KK 624	<i>cinerea</i> var.	Breas – Esmeralda 600-800m
KK 643	sp. (= <i>C. desertica</i> n.n.)	Huasco 200m
KK 654	<i>aureispina</i> n.n.	Margarita, Atacama 1200m
KK 655	<i>tocopillana</i> n.n.	Tocopilla, Mejillones 600m
KK 657	<i>mollicula</i> (near <i>C. hypogaea</i> ?)	Chanaral 200-300m (500m)
KK 658	<i>rubriflora</i>	Sierra Esmeralda 500m
KK 708	<i>calderana</i>	Cerro Copiapo 1000-1200m
KK 709	<i>domeykoensis</i> n.n.	Domeyko 600-1000m
KK 710	<i>coquimbana</i> var. <i>procera</i> n.n.	La Serena 500m
KK 725	<i>applanata</i>	Chanaral 100-300m, (Fray Jorge 300m)
KK 726	<i>intermedia</i>	Vallenar – Copiapo 600m
KK 781	<i>rupestris</i>	Cifuncho - Taltal 120-200m
KK 782	<i>aureispina</i> n.n.	Rio Choros 600-800m
KK 1067	<i>grandiflora</i>	Agua Verde 800m

KK No.	Name	Locality
KK 1068	<i>longistaminea</i>	Cifuncho 400m
KK 1132	<i>minima</i> n.n.	Carrizal Alto 600m
KK 1135	<i>longispina</i>	Hornillos, Copiapo 500m
KK 1138	<i>minima</i> n.n.	Total Bajo 100-200m
KK 1139	<i>minuta</i> n.n.	Total coast 200m
KK 1140	<i>echinata</i>	Monte Amargo, Copiapo 300m
KK 1162	<i>pepiniana</i> (<i>C. cupreata</i> , <i>C. malletiana</i> ?)	Algarrobo 600m
KK 1382	<i>cupreata</i>	Vallenar 800m
KK 1383	<i>cinerea</i> var. <i>dealbata</i> fa. <i>deminuta</i> n.n.	
KK 1384	<i>haseltoniana</i> var.	Paposo - Taltal 200m
KK 1385	<i>tigrillensis</i> n.n.	El Tigrillo, Chanaral 300m (200m)
KK 1386	sp. (<i>C. coquimbana</i> var. <i>deminuta</i> n.n.)	El Tigrillo 100-400m
KK 1387	<i>coquimbana</i> var.	Islon 400-600m
KK 1388	<i>coquimbana</i> var.	San Pablo, Coquimbo 600m
KK 1389	<i>militaris</i> n.n.	Chanaralillo 400-500m (200m)
KK 1390	<i>pseudocoquimbana</i> var. <i>vulgata</i>	Coquimbo, Totalillo 200m
KK 1391	<i>pendulina</i>	Fray Jorge 200m
KK 1391	<i>multicolor</i> (= <i>C. megarhiza</i> var. ?)	Copiapo 600m
KK 1392	<i>tocopillana</i> n. n.	Tocopilla 300-400m
KK 1393	<i>lembckei</i> var. <i>magnifica</i> n.n.	Caldera 100-200m
KK 1395	<i>borealis</i> ?	
KK 1396	sp. (= <i>C. borealis</i> ?)	Antofagasta, Cerro Moreno 300m
KK 1398	<i>uhligiana</i> n.n.	Esmeralda 100-600m
KK 1399	<i>bridgesii</i>	Chanaral 200m
KK 1434	<i>cinerea</i> fa.	Cifuncho 500m
KK 1435	<i>coquimbana</i> var.	Algarrobito 400m
KK 1436	<i>desertorum</i> n.n.	road to Algarrobo, Huasco Alto, 400m
KK 1437	sp. (= <i>C. echinata</i> var. <i>borealis</i> ?)	
KK 1438	<i>cinerea</i> var. <i>dealbata</i> fa.	Carrizal Bajo 200-300m
KK 1535	<i>desertorum</i> (= <i>C. longistaminea</i> ?)	Cifuncho 200m
KK 1537	sp. (= <i>C. variispinata</i> = <i>C. melanohystrix</i> ?)	Esmeralda 100m)
KK 1578	<i>aurata</i> n. n.	Total 300m
KK 1586	<i>uhligiana</i> var. <i>aureispina</i> n.n.	Chanaral 100-300m
KK 1656	<i>pendulina</i> var.	Fray Jorge - Talinay 300m
KK 1708	<i>eremophila</i> (near <i>C. haseltoniana</i> ?)	Paposo 600m
KK 1709	<i>maritima</i> n.n. (near <i>C. humilis</i> ?)	Paposo 50-100m
KK 1713	<i>horridispina</i> n.n.	Copiapo 500m
KK 1715	<i>monteamarguensis</i> n.n.	Caldera 300m
KK 1716	<i>brunescens</i>	Copiapo 400-500m
KK 1728	<i>deserticola</i> n. n.	Castilla 500m
KK 1729	<i>echinus</i> n.n.	Copiapo, Monte Amargo 500m
KK 1730	<i>pepiniana</i> var. <i>straminea</i> n.n.	Castilla 300m
KK 1731	<i>grandiflora</i>	Cifuncho 100-200m
KK 1732	<i>grandiflora</i> var. <i>grandiflora</i> n.n.	Esmeralda 200m
KK 1733	<i>esmeraldana</i> n.n.	Esmeralda - Chanaral 100m
KK 1734	<i>cinerea</i> var. <i>minicarpa</i> n.n.	Taltal 300m
KK 1735	<i>cinerea</i> var. <i>caespitosa</i> n.n.	Taltal 200-400m
KK 1741	<i>serpentsulcata</i>	Chanaral 300m
KK 1750	<i>uhligiana</i> n.n.	Esmeralda 100-200m
KK 1856	<i>rubriflora</i>	Taltal 200m
KK 1857	<i>coquimbana</i> var. <i>chaniarensis</i> n.n.	Domeyko, Chanar 300m
KK 1858	sp. (= <i>C. olivana</i> ?)	Esmeralda 300m
KK 1859	sp. (= <i>C. scopulina</i> = <i>C. krainziana</i> ?)	Taltal 300m
KK 1860	<i>tocopillana</i> n.n.	Tocopilla 200-300m
KK 1861	sp. (= <i>C. hornilloensis</i> ?)	Los Hornillos 500m
KK 1862	<i>coquimbana</i> var. <i>armata</i> n.n.	Rio Choros 100m
KK 1864	<i>columna-alba</i> fa. <i>nuda</i> n.n.	Cifuncho 200m
KK 1865	sp. (= <i>C. tenebrosa</i> , <i>C. melanohystrix</i> , <i>C. uhligiana</i> ?)	Taltal 400m
KK 1866	<i>serpentsulcata</i> var. <i>castanea</i>	Esmeralda - Chanaral 300m
KK 1867	<i>melanohystrix</i> (= <i>C. uhligiana</i> ?)	Esmeralda 300m
KK 1868	<i>cinerea</i> fa.	Taltal, Breas 500m
KK 1869	sp. (= <i>C. carrizalensis</i> = <i>C. dealbata</i> ?)	Carrizal 300m
KK 1870	sp.	Paipote 800m
KK 1915	sp. (= <i>C. longispina</i> , <i>C. megarhiza</i> ?)	Copiapo, Hornillos 500m
KK 1971	sp. (= <i>C. desertorum</i> ?)	Cifuncho 300m

Alfred Lau (Lau)

Lau No.	Name	Locality
Lau 806	<i>tocopillana</i>	Tocopilla
Lau 808	<i>marginata</i>	Antofagasta
Lau 810	<i>humilis</i>	Paposo
Lau 813	<i>haseltoniana</i>	Paposo
Lau 816	<i>olivana</i>	above Paposo
Lau 817	<i>desertorum</i>	Cifunchos
Lau 818	<i>cinerea</i>	Cifunchos
Lau 820	<i>cinerascens</i>	Pan de Azucar
Lau 821	<i>cinerascens</i>	Las Bombas
Lau 825	<i>lembckei</i>	N of Chanaral
Lau 826	<i>chanaralensis</i>	Pan de Azucar
Lau 829	<i>bridgesii</i>	N of Cladera
Lau 830	<i>mollicula</i>	Chanaral
Lau 831	<i>echinata</i> var. <i>borealis</i>	Copiapo
Lau 832	<i>dura</i>	Totoral
Lau 834	<i>totalensis</i>	Totoral
Lau 838	<i>alticostata</i>	Freirina
Lau 840	sp.	S of Vallenar
Lau 841	<i>pseudocoquimbana</i>	Choros Bajos
Lau 851	sp.	Ovalle
Lau 854	<i>coquimbana</i>	El Sauze
Lau 862	<i>carrizalensis</i>	Carrizal Bajo
Lau 863	<i>echinata</i>	Carrizal Bajo
Lau 864	<i>borealis</i>	Copiapo
Lau 865	<i>lembckei</i>	Caldera
Lau 867	<i>cinerascens</i>	Pan de Azucar
Lau 870	sp.	S of Taltal
Lau 871	<i>krainziana</i>	Taltal
Lau 872	sp.	nr Esmeralda
Lau 874	<i>longistaminea</i>	Esmeralda
Lau 875	sp.	Caldera
Lau 876	<i>tenuissima</i>	Punta Cobre 500m
Lau 883	<i>dealbata</i>	Carrizal Bajo 200m
Lau 884	<i>echinata</i>	Carrizal Bajo 200m
Lau 885	sp.	Carrizal Bajo 200m
Lau 891	<i>loui</i>	Esmeralda
Lau 893	<i>cinerea</i> var. <i>albispina</i>	N of Taltal
Lau 894	<i>gigantea</i>	above Paposo 500m
Lau 895	<i>alticostata</i>	Freirina
Lau 896	<i>ferox</i>	Blanco Encalado

Ken Preston-Mafham (PM)

PM No.	Name	Locality
PM 198	<i>cinerea</i>	Taltal
PM 199	<i>cinerea</i> var. <i>gigantea</i>	Santo Domingo
PM 200	<i>humilis</i>	Paposo
PM 202	<i>cinerea</i> var. <i>gigantea</i>	Paposo
PM 203	sp.	N Taltal
PM 205	<i>cinerea</i>	N Taltal
PM 205a	<i>krainziana</i> f.	N Taltal
PM 205b	<i>krainziana</i> var. <i>scopulina</i>	N Taltal
PM 206	<i>krainziana</i>	N Taltal
PM 209	<i>grandiflora</i>	Esmeralda
PM 210	<i>cinerascens</i>	Pan de Azucar
PM 210a	<i>cinerascens</i>	N Pan de Azucar
PM 210b	<i>cinerascens</i>	S Pan de Azucar
PM 210c	<i>cinerascens</i>	E Pan de Azucar
PM 212	<i>serpentsulcata</i>	Pan de Azucar
PM 213	<i>cinerascens</i>	Chanaral
PM 215	<i>echinata</i> var. <i>borealis</i>	Monte Amargo
PM 219	<i>marginata</i>	Morro Copiapo
PM 220	<i>echinata</i>	Total Bajo
PM 221	<i>dura</i>	S Total
PM 222	<i>carrizalensis</i>	Carrizal Bajo
PM 225	<i>echinata</i>	Carrizal Bajo
PM 227	<i>dura</i>	S Carrizal Bajo
PM 228	<i>carrizalensis</i>	S Carrizal Bajo
PM 230	<i>dura</i>	20km E Carrizal Bajo
PM 232	<i>megarhiza</i>	Paipote
PM 261	<i>bridgesii</i>	Chanaral airfield

Friedrich Ritter (FR)

FR No.	Name	Locality
FR 205	<i>boliviana</i>	Antofagasta
FR 207	<i>cinerea</i> [sparsely spined]	Taltal
FR 207a	<i>cinerea</i> var. <i>albispina</i> =266	10km N Taltal
FR 207b	<i>cinerea</i> [more strongly spined]	
FR 208	<i>gigantea</i> var. <i>haseltoniana</i>	Paposo
FR 208a	<i>eremophila</i> =476	E Paposo
FR 208b	<i>gigantea</i> var. <i>gigantea</i>	
FR 209	<i>cinerea</i> x <i>krainziana</i> natural hybrid	N Taltal
FR 209a	<i>krainziana</i> var. <i>scopulina</i>	
FR 210	<i>krainziana</i>	N Taltal
FR 211	<i>rubriflora</i>	S Taltal
FR 211a	<i>montana</i> =522	Taltal
FR 216	<i>cinerascens</i> var. <i>intermedia</i>	Barquito
FR 230	<i>pseudocoquimbana</i> var. <i>vulgata</i> =649	Coquimbo
FR 230a	<i>pseudocoquimbana</i> var. <i>chaniarensis</i>	Carrizalillo
FR 231	<i>megarhiza</i>	Toledo
FR 231a	<i>megarhiza</i> var. <i>microrhiza</i>	Paipote
FR 245	<i>bridgesii</i>	N Chanaral airfield
FR 245a	<i>marginata</i> var.	Flamenco
FR 246	<i>serpentsulcata</i>	N Chanaral
FR 247	<i>pseudocoquimbana</i> var. <i>pseudocoquimbana</i> =1086	
FR 251	<i>fiedleriana</i>	Huasco
FR 261	<i>hypogaea</i>	Chanaral
FR 266	<i>cinerea</i> var. <i>albispina</i> =207a	
FR 464	<i>humilis</i>	
FR 476	<i>eremophila</i> =208a	E Paposo
FR 504	<i>pendulina</i>	Frai Jorge
FR 505	<i>longispina</i>	Sierra Hornillo, S Copiapo

FR No.	Name	Locality
FR 506	<i>echinata</i>	Carrizal Bajo
FR 506a	<i>echinata</i> var. <i>borealis</i> =512	S Monte Amargo
FR 506b	<i>echinata</i> var. <i>borealis</i> fa. <i>pulla</i>	15km E Carrizal Bajo
FR 507	<i>calderana</i>	N Caldera
FR 508	<i>carrizalensis</i>	Carrizal Bajo
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FR 512	<i>echinata</i> var. <i>borealis</i> =506a	S Monte Amargo
FR 522	<i>montana</i> =211a	N Taltal
FR 523	<i>grandiflora</i>	Esmeralda
FR 524	<i>cinerascens</i>	N Chanaral
FR 525	<i>mollicula</i>	N Chanaral airfield
FR 526	<i>taltalensis</i>	Qu.Cachina, Taltal
FR 527	<i>chaniaralensis</i>	S Chanaral
FR 528	<i>rupestris</i>	Cifuncho
FR 529	<i>desertorum</i>	E Cifuncho – Las Breas
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FR 531	<i>longistaminea</i> =532	Esmeralda
FR 539	<i>tenuissima</i> =540	S Antofagasta
FR 541	<i>solaris</i>	El Cobre
FR 546	<i>dura</i>	E Totoral
FR 649	<i>pseudocoquimbana</i> var. <i>vulgata</i> =230	
FR 654	<i>hypogaea</i> var. <i>barquitensis</i>	Barquito
FR 711	<i>serpentsulcata</i> var. <i>castanea</i>	24km N Chanaral
FR 717	<i>alticostata</i>	N Nicolasa
FR 718	<i>coquimbana</i>	15km E La Serena
FR 718a	<i>pseudocoquimbana</i> var. <i>vulgata</i> =230	
FR 722	<i>calderana</i> var. <i>spinosior</i>	20km S Barquito
FR 1057	<i>tocopillana</i>	N Tocopilla
FR 1086	<i>pseudocoquimbana</i> var. <i>pseudocoquimbana</i> =247	
FR 1087	<i>vallenarensis</i>	Vallenar airfield
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FR 1148	<i>paposoensis</i>	20km N Paposo
FR 1149	<i>hornilloensis</i>	Cerro Hornillo, N Esmeralda
FR 1316	<i>calderana</i> var. <i>spinosior</i>	20km S Barquito
FR 1443	<i>olivana</i>	Oliva bay, N Taltal
FR 1444	<i>tenebrosa</i> =476a	E Taltal
FR 1447	<i>variispinata</i>	50km N Paposo – 30km S Blanco Encalada
FR 1452	<i>rarissima</i>	3km S Paposo
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All photographs are taken by the author except those marked as shown, which were kindly provided by the individuals listed below.

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‡	Tom Jenkins	†	John Ede	Δ Chris Pugh

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Fig.106 *Copiapoa cinerea* var. *gigantea* (*albispina*) in habitat north of Taltal

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Graham Charles has been growing cacti and succulents since the age of 12, and has been a qualified judge for over 25 years. He has always been particularly interested in South American cacti, and over the years has amassed a large collection of documented plants.

Graham has made several trips to South America to observe the plants in their native habitats; he has written a number of articles for UK journals, and is a popular speaker in Britain. He shares his hobby, and his glasshouse, with his wife, Elisabeth, who is also a keen grower of succulent plants.

Graham is enthusiastic about what he calls practical conservation, reducing the demand for field collected plants by growing seedlings from habitat collected seed. He distributes these through 'The Chileans', a specialist Society for the study of South American cacti.



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